Sustainable housing in Ethiopia

A diffusion analysis of the Adobe technique

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Abstract

The purpose of this study is to evaluate the diffusion of the Adobe sustainable housing technology in Ethiopia. There are multiple factors either generating or restraining the diffusion of the technology, these factors are viewed and analyzed by an Innovation theory. During an 8 week field study empirical data has been gathered from multiple geographical areas. A multiple case study approach has been adopted and through qualitative interviews with stakeholders and technical inspections of Adobe buildings, data has been documented. In conclusion the technological diffusion of innovation has reached different levels in the different cases. Presented is how the rate and level of diffusion is interdependent with natural resources depletion, positive or negative demonstrations, knowledge diffusion as well as profitable or unhelpful interplay between micro and macro players present on the Ethiopian housing market.
Foreword

This study has been conducted in Ethiopia as a final year project for a B.Sc degree in Construction engineering at Halmstad University. A Minor Field Study scholarship was granted by Swedish International Development Agency (SIDA), funding the field study executed in the spring of 2015. We’d like to thank both Halmstad University and SIDA for this possibility.

The study would not at all be possible without the support and encouragement of the people engaging in the field trip and the preparations. Therefor we would like to thank our supervisors Bengt Hjort at Halmstad University and Workneh Hechamo, our supervisor in field. Further our hosts Sture & Elsie Bengtsson and Workneh & Hanna-Karin Stark, who with their long experience opened Ethiopia for us and spoiled us during our stay. They deserve the warmest of thanks and our gratitude is immense. The cooperating organizations; Solid Earth Africa (SEA), Habitat for Humanity, Buildings trade school (BTS) Challiya, KLM and EECMY & DASCC have made an unbelievable effort in supporting us with time, information and resources. Also a big thanks to Swedish Lutheran Mission in Addis Abeba and Qes Endale Awgichew for taking care of us and making us local Ethiopians.

In conclusion we would like to thank all the other people who have contributed to our study by answering questions, welcomed us into their homes and made our stay in Ethiopia one of the dearest memories of our life.
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Definitions & Acronyms

Definitions
Adobe - construction material made by soil, grass and water
Chickablockets – local expression for Adobe blocks

Acronyms
BTS - Building Trade School
CSSB - Cement Stabilized Soil Block
DASSC - Development And Social Service Commission
EECMY - Ethiopian Evangelical Church Mekane Yesus
ETB - Ethiopian Birr (currency)
GDP - Gross Domestic Product
HCCB - Hollow Core Cement Block
NGO - Non Governmental Organization
SEA - Solid Earth Africa
SIDA - Swedish International Development Agency
USD - United States Dollar (currency)
R&D - Relief and Development
Summary

As one of the poorest countries in the world, Ethiopia is problematized by high population growth, rapid urbanization, housing stock shortage, erosion, lack of education and depletion of natural resources. To cope with the challenges that these problems generate, the Ethiopian housing sector needs to reach a sustainable solution where both the environment is protected and the population is housed. The traditional Chicka building technology consumes large amounts of lumber and faces a shortened lifespan due to increased problems with termites. To build houses based on concrete is out of reach for large parts of the rural population, as both logistic and economic resources are insufficient.

The Adobe technology offers a viable technology with a low threshold, as the main component is soil and the blocks can be produced by anyone. Adobe blocks are made of soil, water and in most cases some kind of straw, mixed and then fermented, before compressed manually in a form and then released and dried. The properties of the blocks are dependent on the composition of the soil, making the technology more viable in certain areas. The only structural component that consists of other materials than Adobe blocks is the roofing, making the technology available and affordable. The construction technology is based on the same premises as normal masonry, providing a partly incremental innovative technology with an easy-to-learn method of construction.

Since 2002 several studies concerning Adobe technology have been conducted by Halmstad University in Ethiopia, including demonstrations, analysis of soil properties and attitudes. This study analyzes the diffusion of Adobe technology in Ethiopia, and the parameters affecting it. Through a comprehensive field study different areas have been analyzed. In order to give a holistic view of the diffusion in Ethiopia, a multiple case study-method has been used. This with innovation theory models used to identify and evaluate different diffusion catalysts and how the interplay between a macro and micro level of stakeholders affect the diffusion within a certain areas.

The report concludes that the decentralized, multi-cultural and multilingual context in Ethiopia often constrains the diffusion and adoption of Adobe technology used in construction. Even though the technology show of notable advantages compared to traditional methods, the knowledge-deficiency often acts as a deterrent. Large-scale diffusion has been observed in areas where extensive resource depletion has occurred, and in turn limited the availability of lumber. This makes the traditional construction techniques unavailable, and creates a forced diffusion of the Adobe technology. In areas where long-term implementation efforts have been made, the technology has diffused even though the availability of forest is still high. In areas where the implementations efforts have halted, the technology and knowledge has slowly faded away as traditional and more modern technologies have been adopted in its place.
1 Introduction

1.1 Background
Ethiopia is a country threatened by environmental and demographic changes. An intense growth of population has caused large scale deforestation due to cultivation, grazing of land, lumber-intensive construction and firewood consumption. The national housing stock is of substandard quality and insufficient quantity due to the high annual population increase. At the same time the natural and environmental resources of the country are severely depleted. Both in rural and urban areas the intense domestic growth is causing increased demand for sustainable low cost housing materials. Because of the high consumption of wood in traditional construction methods and fuel consumption during food preparation, other more sustainable, available and affordable techniques are under investigation. Efforts to implement sustainable construction materials and methods are frequently made by stakeholders, and afforestation efforts are also implemented to restore Ethiopia's natural resources. The Adobe technique is an ancient technique and is argued to provide a sustainable, affordable and available construction technique to ease Ethiopia’s present and future housing situation and resource depletion. (Allerbo & Waldemarsson, 2013)

1.2 Aim
The aim of this project has been to study and analyze different factors affecting the spread of the Adobe building technology in Ethiopia.

1.3 Method
During an eight-week field study case studies have been conducted in different parts of Ethiopia. The cases have been studied through interviews, observations and technical inspection reports. This was preceded by literature studies of relevant topics i.e. Ethiopia, theoretical paradigms of Innovation and Adobe technology.

1.4 Limitations
This report is limited to houses constructed with Adobe technology, including the factors affecting the diffusion of the technology. The report is geographically limited to Ethiopia.
2 Ethiopia - A short description

2.1 Population
The federal democratic republic of Ethiopia is the most populous landlocked country in the world, hosting 94.1 million people as of 2013 with an annual growth of 2.9% according to the World Bank, 2015. The median age of the population is 17.6 years and their life expectancy is 60.75 years, ranking at place 193 out of 223 countries in the 2014 census (CIA Worldfactbook, 2015). The infant and U5MR (under-5 mortality rate) has dropped by more than 50% during the last 25 years according to (Unicef, 2015).

The population is built up by several ethnic groups including the Oromo (34.4%), Amhara (27%), Somali (6.2%), Tigray (6.1%) and Sidama (4%), and is home to a religious variety where the Orthodox (43.5%) is the leading religion followed by Muslim (33.9%) and Protestant (18.5%) according to a 2007 estimate by (CIA Worldfactbook, 2015). There are 88 individual languages spoken in Ethiopia (Ethnologue, 2015). The country is classified as 'Low human development', ranking at 173 out of 187 countries according to the HDI measurements issued by (UNDP, 2015) in 2014.

2.2 Geography & environment

Ethiopia, which is located in eastern Africa just inland of Somalia, lost its only coastline along the red sea due to the independence of Eritrea in 1993. The total covered area of Ethiopia is 1,104,300 km² and is host to 83.1 people/km² according to (UNdata, 2015). The climate
includes tropical monsoons and is affected by large topographic induced variations, as the altitude varies from 125 m under sea level at the Danakil Depression to 4,533 m above sea level on the top of Ras Dashen (CIA Worldfactbook, 2015). Table 1 shows how the altitudes are divided into climate zones.

<table>
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Table 1 - Climate zones of Ethiopia (Government of Ethiopia, 2015)

The natural resources of Ethiopia have severely depleted during the last century due to grazing, cultivation, firewood consumption and lumber-intensive construction spurred by the population increase. According to the studies of (Debelo & Degaga, 2014) termite resistant tree species were almost extinct in certain areas, due to their favorable constructional properties and also due to the introduction of Eucalyptus trees. Observations indicate that the deep root system of Eucalyptus steal a large part of the water from other tree roots, eradicating the other tree species. Although the estimations of the deforestation in Ethiopia during the last century are contradictory, several reports point to the fact that the extent of it has increased the erosion and desertification (Birhanu, 2014)(Stiles et. al, 1991). According to (UNDP, 2015) Ethiopia has decreased it’s forest covered area by 20% between 1990 and 2011. Studies done by (Tamene & Vlek, 2008) show that Ethiopia loses 1.5 billion tons of topsoil annually from the highlands, which is equivalent to 1.5 million tons of grain. This is caused by the steep topography, high intensity of rain storms, degraded vegetation, extensive cultivation and overgrazing of cattle.

2.3 Political governance

The democratic republic of Ethiopia is a currently ruled by the coalition Ethiopian People's Revolutionary Democratic Front. The country is divided by the federal constitutions in a “four-tier decentralization framework” (African Development bank, 2009). There are 9 ethnically determined regions. These consist of zones (clusters of districts), woredas (districts) and kebeles (neighbourhoods). The 9 regions are Tigray, Amhara, Somali, Oromia, Afar, Ye Debub Biheroch Bihereseboch na Hizboch, Gambela, Harari,Binshangul-Gumuz. There are also two self-governing administrations, the administrations of Addis Ababa and Dire Dawa (CIA Worldfactbook, 2015).
The political system is built up by a parliamentary structure consisting of the House of Federation and the House of Peoples’ Representatives, which are elected for five year terms. The House of Peoples’ Representatives elect the Prime Minister and approve the members of the Prime Minister’s cabinet. Figure 2 shows the Hierarchy ladder of the governmental structure.

2.4 Economic

The Gross Domestic Product (GDP) of Ethiopia is 47.53 billion United States Dollar (USD) and the annual GDP growth has averaged in excess of 10% during the last 10 years, making it the fastest growing non-oil exporting country in Africa (World Bank, 2015). The GDP per capita is although at 505 USD, ranking at 211 out of 227 countries (World Bank). The economy is largely dependent on agriculture as it occupies 85% of the labor force and stands for 45% of the GDP as of 2013 (World Bank, 2015; CIA Worldfactbook, 2015). The main exports include coffee, flowers, oilseeds and gold, according to 2013 estimates there is a trade deficit of 7.47 billion USD (CIA Worldfactbook, 2015).

The agricultural sector has a history of poor water management and frequent draughts, although efforts from foreign donors and the Ethiopian government in recent years have increased the agricultural resilience. Currently a diversification where manufacturing, textiles and energy generation are expanding, have increased the economic variety as part of ‘Ethiopia’s Climate Resilient Green Economy Strategy’ which aims to bring Ethiopia to middle-income status by 2025. Several sectors including insurance, banking, telecommunications and micro-credit industries are limited to domestic investors, but significant foreign capital has been invested in commercial agriculture, leather, textiles and manufacturing(CIA Worldfactbook, 2015).
2.5 Housing & Infrastructure

According to (Unicef, 2015) 17.2% of the Ethiopian population was living in urban areas by 2012, with a predicted annual increase of 4.1% until 2030. It is estimated that 20.7% of the population had access to improved sanitary facilities by 2011, and 49% to improved drinking water (Unicef, 2015). The Ethiopian constitution states that all land is owned by the government, whom provide long-term leases and in some areas land use certificates with recognizable rights for continued occupancy (CIA Worldfactbook, 2015). The leases run for 99 years concerning owner occupied holdings and 50 years for others, including commercial real estate (Tesfaye, 2007).

The urbanization is causing widespread problems in larger cities, as the accumulated demand exceeds the supply of housing. The consequence is that prices are being pushed beyond the reach of the majority of residents (Tesfaye, 2007). As the income and assets of low- and medium income Ethiopian households are limited, the market of housing loans is plagued with insufficient collateral and high risk. The supply of housing is hamstrung by the shortage of serviced residential plots in cities, price of construction materials also increases (Tesfaye 2007). According to a report by (UN-Habitat, 2008), it is estimated that 80% of urban dwellers live in substandard housing. In rural areas 86% of the population are said to be living in traditional Chica houses, out of which 52% are stated to be overcrowded (Kumie, 2002).

2.6 Termites

According to (Krishna & Weesner, 1970) there are 2800 species of termites, out of which 185 are known as harmful to agricultural settings and housing structures. Termites provide recycling of organic matter, improved soil fertility and act as food for other creatures (Debele & Degaga, 2014). It is estimated by (Geer, 2005) that the global cost of structural damage due to termites in urban areas are 15-20 billion USD annually. Studies of (Palin et al. 2011) show that the termite species density and abundance declines with increased altitude, with no termites being found above 1850m. This is confirmed by (Gathorne-Hardy & Eggleton, 2001) who also point to the fact that this is in accordance with declining air- and soil temperatures. This is supported by the studies of (Stevens 1992) who point to the monotonic decrease of species richness due to elevation, often attributed to temperature reduction.

Termites are a common problem in Ethiopia and are widely distributed throughout tropical and subtropical regions (Wood, 1991). Studies conducted by (Debele & Degaga, 2014), of the Central Rift Valley, show of over 90% infestation of houses. (Debele & Degaga, 2014) point out western Ethiopia as an especially termite-prone area. Common features for these areas include semi-arid climate and annual precipitation of under 1000mm. The studies of (Debele & Degaga, 2014) also point to the fact that houses constructed with wooden walls have shorter lifetimes than houses built by mud bricks, as the wooden walls will lose support and eventually collapse. The impact of termites on houses built by mud blocks is low due to the fact that termites only move through the walls in order to reach the organic material on the roof, and therefore have only a small effect on the integrity of the walls of mud brick houses.
3 Adobe technology

3.1 General background

The Adobe technology is argued to be a sustainable way of constructing homes and buildings. It is used not only in Africa and Ethiopia but also in many other parts of the world, where the soil conditions are suitable. In Arizona, USA for example, the technique is being implemented and business is made from industrialized block production (Arizona Adobe C. 2015). In an article published by architect (McHenry, 2000), who has also published literature and papers in the topic, it is stated that the technique has been used in New Mexico for many centuries and that it was introduced in other parts of USA during the economic depression in the 1930’s. According to (Zami & Lee, 2009) 50% of the world’s population live in homes based on some type of mud technology. (Zami & Lee, 2009) also argues in a report that; “Soil has been, and continues to be, the most widely used building material throughout most developing countries: it is cheap, available in abundance, and simple to form into building elements”.

Adobe technology is a Low Impact Development technology which is defined by (Fairle, 1996) as: “temporary (nature’s timescale), made with local materials, small scale, protects wildlife and human wellbeing (no toxic materials or processes), small amount of non-renewable resources and is linked with a living philosophy that aims to protect the environment”. (Frescura, 1981) writes, “in addition to its political, economic, social and ecological advantages, earth has great cultural and architectural importance”.

The general perception of Adobe blocks is that they are simple to produce, affordable, and a product that could easily be available on the Ethiopian market. As such it could have a great impact on the living situation and improvement of the standard of the building stock of Ethiopia’s rural and suburban parts, while also contributing to a sustainable development in a country affected by resource depletion. The technology has at time been given the descriptive synonym of “the property of everybody” (Hjort & Sendabo , 2006).

3.2 Production, Composition and Soil mix

Adobe blocks are defined as stabilized soil block (SSB), which are made from a mix of soil and water and, at times, reinforced with straw or fibres. The Adobe block can be made out of several soil types, although the durability of the block will be affected by it’s composition and method of production. (Afkari, 2010) and (Kesaya, 2015) say that tests need to be done to determine the suitability of a soil mix. There are multiple ways of testing the soil suitability. (Houben & Guillaud, 1994) mentions bottle, shrinkage, lustre and adhesion test as appropriate soil tests for examining sustainable soil for Adobe block production. In the (Allermo and Waldemarsson 2013) study it is differentiated between “Highland and Lowland soil”, where the highland soil is composed by clayey silt without any coarse fractions, such as sand and the lowland soil is of a silty -sand soil, without clay. (Asfaw, 2015) argues that the red soil, containing a high proportion of clay, is more suitable for Adobe production because of the plastic properties of the soil, which is partly confirmed by
(Allermo and Waldemarsson 2013) whose results shows that the highland soil mix “released the mould easier” than the sandy lowland soil. (Allermo and Waldemarsson 2013) do argue that the lowland soil is easier to work with and has more cement like properties. Tests done by (Kesaya, 2015) has shown that a clay ratio of up to 20% is appropriate for the Adobe block production, and for the mortar and plastering a clay ratio up to 50%. During his studies (Kesaya, 2015) concluded that red, black, brown and white soil mixtures can all be used (see picture 1), although the properties depend on the grain size distribution of the mix. Observations show that two Adobe houses with the exact same colour and composition of the soil mix are rare, which further indicates that many types of compositions of soil are used. (Asfaw, 2015) states that the time of fermentation, amount of water, grain size distribution, type of reinforcement and production method determine the durability, although adaptations and adjustments can help maximize the durability of the different soil types.

After mixing the soil it is recommended to let it ferment for a few days before shaping it into blocks with the help of frames, often made out of wood. After shaping, the blocks are left to dry, preferably in the shade to avoid cracks due to rapid evaporation from the blocks. Depending on the soil type and the grain size distribution of the soil, it might be preferable to add extra reinforcement. The reinforcement usually consists of grass or straw, depending on the local context and availability. (Ghavami et. al, 1999) states that fibres from cow dung, lime and termite heap material can increase compressive strength of a Adobe block by 15%. Since these materials help to transport moisture they can also prevent cracking in the material when the blocks are drying. After erection it is advisable to protect the walls by adding a protective cover to ensure that the blocks are not exposed to wetting due to rain. This can be done in many different ways, e.g. with plastic paint, plastering with cement, cow dung or adobe mix. Lime plaster, lime wash and/or silica paint are other appropriate materials used to strengthen the blocks water resistance properties (Chiras D, 2002). The financial situation, awareness and availability are often the deciding factors for the selection of plastering method.
Important structural details

The reasons for selecting Adobe blocks as a construction material, is often availability and lack of major financial assets. Due to this, the most economical way of building a foundation is to use the Adobe block itself. As the blocks are sensitive towards moisture it is very important to protect the house against rain and storm water. Simple measures can be done to ensure that the foundation and the walls are kept dry. A well dimensioned roof overhang and sloping the surrounding area [>1:20] away from the building are simple but important ways of securing the structure (Johansson & Wartanian, 2008). If finances are available, it is recommended to use a foundation wall made from stone, as it is water resistant and can prevent capillary suction of water from the ground into the Adobe-wall. This also helps to prevent settling and cracking of the walls. In Ethiopia it has been understood and observed that the roof structure need to be anchored to the walls or foundation in order to prevent damages on the roof because of high wind forces (Kruse, 2015).

3.3 Pros & Cons

Adobe is an excellent material in regions where slow velocity of temperature in a material is of benefit. A high thermal density provide a low-velocity material (Hu & Cao, 2009), suitable for the hot days and cold nights that Ethiopia's climate situation is providing.

An estimated Life Cycle Analysis (Bauman & Tillman, 2004) shows Adobe constructions to be beneficial. Minimal amount of manufactured products i.e. cement, nails and metal products, chemicals, energy intensive transportation and extraction of raw materials etc. are needed for the structural parts. Adobe therefore has minimal impact on nature and a minimal contribution to the Greenhouse effect.

Adobe technology is a time consuming and labour intensive technology, which can be seen as a downside. The possibility to produce the blocks and construct a house, with limited education and experience, is what makes the technology affordable and available. (Weissman & Bryce, 2011) states about earth constructions; “It has no threshold and can be used regardless of economic potential and social status”.

Other advantages mentioned in the literature studies are: simplicity, noise absorbent, adaptability, fireproof, low energy in- and out-put (Allerbo & Waldemarsson, 2013)

And disadvantages mentioned in the literature are: brittleness, low tensile strength, very high shrinkage/swelling rate, low abrasion resistance (Allerbo & Waldemarsson, 2013).
3.4 Adobe adaptations
Adobe is a material used not only for the structural parts of the building, but in some areas the mud blocks are used as fences, stoves and furniture in all different kinds.

3.5 Chicka - the traditional building method
Adobe is a challenger to the traditional construction method in Ethiopia, the Chicka house. The Chicka house is erected with wooden structural timber walls which are plastered with the same mixture as Adobe (Hjort & Sendabo, 2011) Timber poles sometimes made out of termite resistant woods like Thid (Juniperus Procera Hochst) or Kosso (Hagenia Abyssinica), are put into the soil with a regulated distance. Split timber is then added in between as the structural walls. Because of rapid deforestation with resource depletion, the termite-resistant species mentioned above have become rare and expensive. These species have been replaced by Eucalyptus (Globus Labill and Camaldulensis Dehnh) which are fast growing and today stand for the majority of constructional timber in Ethiopia. Eucalyptus is not as durable as Thid and Kosso, and it is much less termite resistant. The lifespan of a Chicka building in a termite ridden area, is decreased when using Eucalyptus. Because of rapid deforestation with resource depletion, the termite-resistant species mentioned above have become rare and expensive.
4 Theoretical background

4.1 Innovation Perspectives and paradigms

The perspective of innovation helps to analyse the level of diffusion of Adobe that has occurred in the different areas of Ethiopia. It is assumed in this report that the Adobe technology is mostly attractive to small firm entrepreneurs and local users. According to (Acs & Audretsch 1991) there are four key contributions from small firms regarding innovation and adaption in a market; “they play an important part in the process of technological change, generate much of the turbulence that not only creates an additional dimension of competition but also provide a mechanism for market regeneration and international competitiveness in newly created product niches . . . and job generation”. Relief and Development (R&D) organizations and stakeholders do the promotion effort done for the Adobe technology in order to establish the technique with the small firms, creating a demand market.

According to (Peter B. et. al, 2006) and (Urabe, 1988); “Innovation consists of the generation of a new idea and its implementation into a new product, process, or service, leading to the dynamic growth of the national economy and the increase of employment as well as the creation of pure profit for the innovative business enterprise”. The innovation in the sector of construction can be given a complementary view and is defined by (CERF, 2000) as; “the act of introducing and using new ideas, technologies, products and/or processes aimed at solving problems, viewing things differently, improving efficiency and effectiveness, or enhancing standards of living”.

4.1.1 The market based- and the resource based- view of Innovation.

Forces in the market and the society of implementation drive innovation. There are two general schools of thought regarding this; The market based and the resource based view of Innovation (Peter B. et. al, 2006). Argument given by the market based view is that the constraints, direction and quantity of the innovational activity by firms is determined and facilitated by the market context and condition (Slater & Narver, 1994). As the construction industry is project oriented, the market based view argues that this factor has a negative influence of the diffusion of innovations. (Winch, 1999) states; “The solutions reached for the particular problem faced on the project must be learned, codified and applied to future projects”. (Dodgson & Bessant, 1996) also emphasize that innovation in the construction sector is spurring from “a problem solving situation on site”. The temporary nature of the industry is based on the short term agreements and relationships between stakeholders, which creates an extremely complicated situation for an innovation to spread and multiply from project to project (Construction Productivity Network, 1997). It is argued that the ability of the stakeholders and promoters of the technology to interpret and sense the precipitating market events that either stimulate or hinders the adoption of the innovation is of great importance regarding the survival of any innovation (Zahra, 1991).
The resource based view argues that the dynamic context of the market is too unstable to be a foundation for an innovation strategy. (Peter B et. al. 2006) argues that; “firms’ own resources provide a much more stable context in which to develop its innovation activity, and to shape its markets, to a limited extent, in its own image”.

4.1.2 Coupling model of innovation

The Coupling model of innovation, elaborated by (Rothwell & Zegveld, 1985) recognizes the need for both technology push and market-pull i.e. market based and resource based view of innovation. This indicates that one of the schools mentioned above is not satisfactory for covering all the factors affecting the adoption of an innovation to a specific targeted market, but both needs to be considered (Dosi & Malerba, 1996).

4.1.3 Incremental- or Radical- innovation

Construction innovation theory often differentiates if the innovation is of an Incremental or Radical innovation nature (Marquis 1988). This is defined by the effect of the innovation on the industry. The incremental innovation is "a small change, based on the current knowledge and experience" (Slaugther, 1998). The incremental innovation is often easily predictable and has a minor interaction with components close to the innovated method or product.

The radical innovation on the other hand, is of a much more impacting kind. It is generally changing the whole industry nature, A breakthrough in science or technique is often classified as a radical innovation. (Nelson & Winter, 1997) argue that “it creates a new way of understanding a phenomenon and formulating approaches through which to solve problems”. The radical innovations are often harder to predict.

4.1.4 Evolutionary Innovation Perspective

Regarding the selection process and variety generation of innovations in the industry sectors the Evolutionary Innovation Perspective provides a theory of how the interaction between the two is creating “resilient accumulations and patterns of the technological innovations” (Lees & Sexton, 2014). The varieties of innovations are introduced to the market by the economical actors, and the selection process is then executed by the market actors. The resultant of the interaction (variation-selection) is the establishment of some innovations and the death of some. The studies of (Nelson & Winter, 1977) determine that macro patterns and behaviours occur from the micro decisions made by firms and users. This is then elaborated by (Dosi, 1982) that argues that trajectories regarding the technological direction of industries are formed by these patterns and behaviours. He argues that companies can be;

“so to speak, ‘blind’ with respect to other possible technical possibilities”.

A technological trajectory, established in an industry is hard to change. (Freeman & Perez, 1988)(Tushman & Anderson, 1986)(Ruttan, 2002) argue that the possibility of change or diminishment to occur through different mechanism, for example introduction of radical new
innovations and discontinued technology. This can be enhanced by environmental regulations enforcing an adaption of technology and help radical innovation to occur, which can change the technological trajectory in the specific industry and market arena (Lu & Sexton, 2011).

4.2 Diffusion of innovation
(Rogers, 2003) presents criteria’s for the diffusion of new innovations, where he argues that the choices of individuals are driven by several different economic, social and technical aspects that diffuse over time in pre-existing conditions. According to (Rogers, 2003) the main impacts on individual decisions are knowledge, persuasion, decision, implementation and confirmation. These are in turn affected by social factors and systems, which combined provide the accumulative diffusion and rate of adoption of the innovation.

The social system will have an impact through the pre-existing system, characteristics and social network of the adopters, environmental characteristics as well as the characteristics and efforts of the promotion agents. Other factors that affect the rate of adoption is the innovation attributes and the type of innovation decision, whether it is optional, collective or generated through authority.

The innovation attributes are defined by (Rogers, 2003) with five perceived attributes, specific to the innovation:

1. “Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes…”
2. “Compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and need of potential adopters…”
3. “Complexity is the degree to which an innovation is perceived as relatively difficult to understand and to use....”
4. “Trialability is the degree to which an innovation may be experimented with on a limited basis…”
5. “Observability is the degree to which the results of an innovation are visible to others…”

The diffusion of innovation theory also defines different segments of adopters which starts with the innovators, followed by early adopters, early majority, late majority and laggards. These groups are categorised by their different needs, preferences, attitudes and abilities in the process of adoption of innovations. (Rogers 2003) argues that it is important that an innovation is adaptable through this process, so that both the innovation and diffusion is fit to meet the requirements of different segments, as their preferences vary.
As the innovations run further on the scale of adoption (Rogers 2003) argues that the importance of mass-media is replaced by peer to peer information spread. Since most possible adopters are prompted to reassure themselves through more reliable communication channels before adopting a new technology, in order to minimize risk. In contrast the innovators are defined as people with access and ability to process more accurate information, and with better economic means to experiment with techniques. The innovators are seen as change agents since their efforts will impact the diffusion, which depends upon their demonstration and review of the innovation being positive or negative.
5 Method

5.1 Multiple-, Descriptive- and Qualitative- Case study
The results of the study are presented in a Multiple Case study, divided into Primary- and subsases. The primary is discussed and analysed in a holistic view in the chapter 8, viewed from the theoretical paradigm given in chapter 4. The subsases are defined in chapter 6, giving the base for discussion and conclusions in chapter 8.

"Case studies prove valuable in situations where existing knowledge is limited” ........
“within business research, a case study is a description of a situation which is sensitive to the context which the research occurs”. (Harris & Ogbonna, 2002);

In a case study, often a phenomenon is investigated in its specific context (Fellows & Liu, 2008). The context in itself provides a multitude of variables that might be hard to analyse with only one approach of gathering data. The empirical sampling selection in this study has been done in cooperation with stakeholders, who are promoting or implementing the Adobe technique in Ethiopia. But additional samplings have been reviewed spontaneously as objects have been observed, inspected or interviewed. The empirics are qualitative, used to determine the intersubjective knowledge and awareness regarding the diffusion of the technique in Ethiopia. The study is best described as a descriptive case study, as it is defined by (Fellows & Liu, 2008); “aimed at systematically identifying and recording a certain phenomenon or progress...” ........ “It is not directly aimed at testing a theory or hypothesis but recording an object of study”.

5.2 Interviews
Through the course of the study semi-structured interviews have been performed in connection with case studies and with stakeholders (See Table 2). The interviews with stakeholders have been held and recorded in English, to later be transcribed. Completing interviews have been done by email with specific stakeholders. The interview questions have originated from a pre-made questionnaire (Attachment A1), which we have used as an template and questions have been chosen depending on the specific interviewee, together with additional follow-up questions. The interviewed stakeholders have been chosen through the involvement of their organizations and specific knowledge concerning the technique. Interviews in connection to inspections have been written down and conducted in the native language of the interviewee. Also these questions originated from the same questionnaire as the others, although aiming, adapting and at times simplifying the questions to maximize the outcome. Due to the turn of events and the multilingual situation in Ethiopia we have been forced to use different translators during the course of our journey, providing at certain times arguable validity.

5.3 Inspections
Technical inspections have been done in order to determine local adaptations and trajectories of the technology, as well as the vulnerability due to specific local climate conditions. A
template has been made to ensure that equivalent data was gathered at all sites. Housing stock design and inspection reports are found in (Attachment A2), coded under the 5 cases.

5.4 Observations
Within this study most of the empirical data has been gathered through personal interviews and inspections of houses. From eight weeks of traveling, living and communicating with various people and stakeholders a lot of information and data was gathered, and not all has been recorded in coded, structured forms. This means that some of the empirical data is recorded as “observations”, knowledge gained during unofficial conversations and events.

5.5 Critical perspective and complications
Awareness has to be given to the fact that we are students with a European-Swedish paradigm, trying to study a building technology in an African/Ethiopian context. Our limited understanding of the culture and the basic values creating the market context must be considered. Ethiopia per say has multicultural and multilingual community which creates a dynamic arena where variables affecting the diffusion of the Adobe technology might differ from region to region. We don’t expect to grasp the full spectrum of paradigms creating the technological trajectories and attitudes of the stakeholders, (local, national and international), concerning the Adobe block technology. Although the gathered data is valid, it should be analysed with caution as many of the stakeholders, promoters and residents may answer compliantly. Our field study has been filled with unexpected circumstances that at times have complicated and limited the amount of data gathered and the possibilities of in-depth studies of certain cases and areas.

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Chapter in Report</th>
<th>Interviewee’s</th>
<th>Inspected building stock</th>
<th>Date of Field study (Month/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harari state chapter</td>
<td>6.1</td>
<td>Residents – 4 Contractors – 2</td>
<td>6</td>
<td>02/2015</td>
</tr>
<tr>
<td>Central Rift Valley</td>
<td>6.2</td>
<td>Residents – 3 Organisational Stakeholder – 1</td>
<td>5</td>
<td>02/2015</td>
</tr>
<tr>
<td>Kambaata</td>
<td>6.3</td>
<td>Organisational Stakeholder – 3</td>
<td>2</td>
<td>02/2015</td>
</tr>
<tr>
<td>East Wollega and West Shoa</td>
<td>6.4</td>
<td>Residents – 2 Organisational Stakeholder – 3 + notes</td>
<td>9</td>
<td>02/2015</td>
</tr>
<tr>
<td>Western Wollega</td>
<td>6.5</td>
<td>Residents – 1 + notes Organisational Stakeholder – 4 Official building users - 2 Contractors - 2</td>
<td>9</td>
<td>02/2015</td>
</tr>
<tr>
<td>General Stakeholders</td>
<td>7</td>
<td>Organisational stakeholder – 4 Governmental – 1</td>
<td>_</td>
<td>01-02/2015</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>32</td>
<td>31 01-03/2015</td>
</tr>
</tbody>
</table>

Table 2 - Overview, Case studies, interviewees and inspections
6. Case Studies – Primary- and subcases

The multiple case studies are divided in 5 primary cases, with a total of 12 subcases, defined in figure 5. In total 31 house inspections and 32 interviews have been done in order to gather the empirical data presented in the cases. In connection with this additional observations have been made.

<table>
<thead>
<tr>
<th>Primary Case</th>
<th>Geographical location</th>
<th>Subcases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Harari state 6.1</td>
<td>East</td>
<td>Alem - Maya Harrar Babile</td>
</tr>
<tr>
<td>2. Central Rift Valley 6.2</td>
<td>Central</td>
<td>Awassa &amp; Zwai Adama</td>
</tr>
<tr>
<td>3. Kambaata 6.3</td>
<td>Central - South</td>
<td>Durame</td>
</tr>
<tr>
<td>4. East Wollega and West Shoa 6.4</td>
<td>Central - West</td>
<td>Ambo Nekempt Idjaji</td>
</tr>
<tr>
<td>5. Western Wollega 6.5</td>
<td>West</td>
<td>Challiya Bodji Aira</td>
</tr>
</tbody>
</table>

Figure 5 - Primary & subcase overview
6.1 Harari state

6.1.1 Alem-Maya

Background and diffusion

Alem Maya is located in the eastern part of Ethiopia, 10 km west of the city of Harar and adjacent to the seasonal freshwater spring Lake Alemaya. The altitude of Alem Maya is 2000 meters above sea level, eliminating the problems of termites and providing a more temperate climate (Falling rain, 2015). The article “Skolinvigning i Haramaja” (Nilsson, G 1954) mentions the construction of a school with Adobe blocks, which is said to be the first Adobe structure in town. (Nilsson, G 1954) mentions local attempts to replicate the technology, although an extension of the school was made by Hollow Core Cement Blocks (HCCB:s) a couple of years later. (Sesay, A 2015) points to the suitability of the local soil for Adobe blocks, and talks about an Adobe production site in town which is nowadays shut down. (Sesay, A 2015) derives this to an increase in self-sustained production, better local economy and higher availability of cement. (Sesay, A 2015) mentions the importance of Adobe in the area due to the large scale deforestation that has affected the area for a long time, limiting the supply of timber and in turn raising the price, making the Adobe a cheaper construction method. (Karim, H A 2015) shows of the low entry level of the technique, as he himself built his first house, studied in (Alem Maya 4) from replication, only purchasing corrugated iron for roofing and windows and doors.

Attitudes

The observations of (Taye, G 2015) show of a scepticism towards the Adobe technology, induced by the weakness to moisture where the traditional Chika method is seen as a stronger structure, and also mentions that he has witnessed the collapse of a house due to floods in the rainy season. It is confirmed by (Karim, H A 2015) that the Adobe technology is locally seen as a low cost building material, as it provides the cheapest construction often contributed to have low strength. (Kebede, N 2015) who is a tenant in an Adobe-house also still prefers cement over the Adobe construction method although he highlights its cheapness and the comfortable climate inside the Adobe structure. As a contractor (Grima, R, 2015) speaks about the increasing popularity of cement, instead of Adobe as a result of the modernization and improved economic situation of the population. He also mentions the local preference of Chika due to it’s strength, stating that “if people don’t have money they build with Adobe”. From his perspective as a contractor (Grima, R. 2015) mentions the high time consumption during Adobe block production and low profitability for a contractor.

Technical documentations and Observations of Adobe Buildings

Studies in the area show that no straw is used in the local Adobe-block construction, and cement plastering is a common technique where iron mesh as reinforcement is only used in rare cases.
6.1.2 Harar

**Background and diffusion**

The city of Harar is located in the eastern part of Ethiopia and is the capital of the Harari region. It is located on an elevation of about 1900 meters and hosts about 131,000 according to a 1994 census (Ethiopian Government, 2015). The city is an UNESCO World heritage site due to the age of the old city, where buildings dated before the thirteenth century built out of stones and plastered with mud still stand. The local soil is of a light red and brown colour, and has seemingly good resistance to moisture compared with other soils.

**Attitudes**

The urbanization provides a climate where concrete is seen as the most viable construction material, while mud construction in general is seen as something restricted to the poor in the outskirts of town. Mentioned is the common awareness about the technology as a “student building” easy to make as a extra study room at the yard.
Technical documentations and Observations of Adobe Buildings

Although a large scale Adobe production site was observed when entering the town, only few houses were observed in the urbanized area.

6.1.3 Babile

Background and diffusion
Located 40 km east of Harar, Babile is an area which has been plagued with large scale deforestation, according to interviewees, a complete extinction of the surrounding forest during the last 30-40 years. Babile is located on an altitude of approximately 1650 meters above sea level (Fallingrain, 2015), putting in the dangerzone for termite infestations. The Adobe technology is widespread and has been around for several generations (Asambari, 2015). Also people from neighboring regions recognize Babile as a local hotspot for the construction method (Karim, H A 2015). The local soil produces a light brown/red colour which can withstand moisture for a long time according to local Adobe producer (Asambari, 2015) and has cement like properties. (Asambari, 2015) mentions that there has been some problems with termites damages on wood in the area, although he hasn’t seen any damages to Adobe houses. When walking around the city observations show of a large quantity of Adobe buildings, and several different production sites for Adobe blocks. Observed is the interdependent relation between a rich wildlife, deforestation and high usage of Adobe, sustainable construction methods are vital to preserve the little forest left in order to prevent the extinction of the local wildlife.

Attitudes
The Adobe technology is completely diffused within the society in Babile, and is seen as a common construction technique. Although concrete could be seen in few structures, the vocational change of (Asambari, 2015) from carpenter to Adobe block producer and house constructor shows of the continued belief and acceptance of the technique. (Asambari, 2015) also mentions that Adobe is preferred in the local area due to its cheapness, reduced construction time as well as the indoor climate.
Technical documentations and Observations of Adobe Buildings

The inspection shows of a new building that is in prime shape, and further confirms that no straw is used in the Harari state for constructing Adobe-blocks. In town the buildings show of a high stock of Adobe buildings, and point towards a good resistance to moisture.

6.2 Central Rift valley

6.2.1 Awassa/Zwai

Background and diffusion

Awassa and Zwai is located south of Nazareth, in the central parts of the Ethiopian Rift Valley. The Rift Valley is seen as low-land Ethiopia with lake Awasa - 129 square kilometres and an elevation of 1,708 meters. Lake Zway - 485 square kilometres and an elevation of 1,636 meters (New World Encyclopedia, 2015). In these specific regions the climate is hotter because of the lower altitude. Due to the relatively low altitude (<1850 meters) and high amount of deforestation in the area, the natural environment for termites are affected by the deforestation and makes them more aggressive towards wood buildings (Kruse, 2015). Observations show of a large quantity of termite nests in the area. The deforestation in the Ethiopian Rift Valley is severe, leaving mostly bushes (Grima. L. 2015), leaving limited amounts of wood and timber for house construction (Bedaso, 2015). Traveling on the main road from Adama to Zwai observations show local Adobe-block production sites, traditional circular and more modern Adobe houses along the way, as the technique is more common than rare.

Many attempts have been made in the area to introduce the Adobe technology to the local population. (Kruse, 2015) tells of a Ph.D. student that spent time in Challiya and then moved onto a “Cleaning water project” in the Zwai area. During his time in Zwai between 2010-2012, he tried to implement the Adobe technology to the local population. Challiya BTS Adobe instructors were involved in assisting and sharing their experience during the project (Asfaw, 2015). (Mandefro, 2015) states that an attempt was made about 50 years ago to
introduce the technology by building a school in the town of Zwai, but the local population, (Mandefro, 2015) argues, is not aware of the technology behind the building. (Hjort & Sendabo, 2011) mentions an interview with Dr Wudnesh Hailu, who describes an attempt to introduce compressed soil-blocks made in and around the town of Awasa in the beginning of the 1980s. Hailu focused on integrated rural development, as a part of her study she tried to introduce and inspire the local population to use the Adobe technology, by building Adobe dwelling houses at the university campus in Awassa. She designed the objects in order to demonstrate its usage in “a traditional design adapted to modern life”. In Dr Wudnesh Hailu’s design, gender aspects and considerations to ensure proper place for animals, sitting place for household, shelves, beds and kitchen were taken. According to (Hjort & Sendabo, 2011), inspired by the Awassa demonstration project, individuals copied the design and constructed similar houses in other areas.

**Attitudes**

Observations show of a seemingly radical diffusion, pointing towards a positive attitude in the region. During the field study objects confirmed the positive attitude towards the technique during the spontaneous inspection of a house, erected in the 1990’s.

**Technical documentations and Observations of Adobe Buildings**

![Picture 19 - Rift Valley 1, Circular building with no plastering, approximately 20 years since erection.](image1)

![Picture 20 - Rift Valley, Awash dam, erection site seen from car.](image2)

### 6.2.2 Adama

**Background and diffusion**

Adama is a city located north of Lake Koka. The lake is elevated at 1,590 meters and the city at 1,712 meters (New World Encyclopedia, 2015). In an article (Hege, 1998) mentioned an attempt to introduce compressed soil blocks in the vicinity of the city of Adama in the beginning of the 1980’s. (Mandefro, 2015) also mentions of an attempt to introduce Cement Stabilized Soil Blocks (CSSB) in Adama by a Ethio-French cooperation called “The Rexcorp project”.
Adobe technology has according to (Bedaso, 2015) been used by local farmers for a long time, who state, “it was a common method”. (Balayne & Negasha, 2015) is confirming the early adoption, their first experience of an Adobe house was in 1989 Ethiopian calendar (i.e. 1996 European calendar).

Habitat For Humanity Ethiopia have been trying to implement the technology in the region for some time. They were granted a plot from the local-government two times to erect dwelling houses in Adama. People that normally would not be able to afford a home were through a micro loan able to build their own homes. On the plot 55 buildings were erected (Bedaso, 2015). Out of this approximately half was erected using Adobe technology, and the other half was done by CSSB blocks. (Mamo, 2015)(Balayne & Negasha, 2015)(Bedaso, 2015) describes how they were engaged during the construction of their homes. They and their families helped produce the blocks and Habitats local masons were hired for the foundations and erection of the buildings. (Balayne & Negasha, 2015) continued to erect one more building at the back of his plot. The secondary building was made by himself, took 1 month and the expenditure was 15 000 Ethiopian Birr (ETB). Habitats calculated cost for a CSSB block house was: 22-25000 ETB and for an Adobe Blocks house: 15-18000 ETB.

**Attitudes**

Adama is a big city and the municipality have restricted the diffusion and usage of Adobe technology in the urban-planed parts of the city. Habitat was only granted two land plots for construction of Adobe and CSSB houses. The municipality has then denied applications for land, as Habitats explicitly have defined the material for construction as CSSB or Adobe blocks. The argument of the municipality was; “modern technology and material need to be used by Habitat for Humanity, as they are a organization with money”(Bedaso, 2015). The people in Adama generally seem to prefer the traditional building method, “chicka houses”, but the increasing rate of deforestation and the resulting scarcity of timer is pushing the timber prices up. This is forcing the traditional trajectory, caused by habits and traditional thinking, to adapt towards a more Adobe friendly market. (Bedaso, 2015) also confirmed the availability and suitability of soil in the Rift Valley area, making the Adobe technology suitable for the local users as the material is available from the vicinity of their homes. When compared with CSSB blocks people tend to prefer Adobe as it is more cost effective. (Balayne & Negasha, 2015) (Bedaso, 2015) shares that they both had a negative perception of the technology the first time they saw it;

"I myself despised, I had a negative attitude towards it.”

...and...

“How can anyone build with this Chickablockets?!”

Through demonstration and experience of the technology today they argue the advantages of the technology, and recommend their friends and neighbours to use the Adobe technology. (Bedaso, 2015) points out that there still is a lack of knowledge and awareness regarding the technology both in the rural and urban parts of the region. (Students tenants Adama, 2015)
showed of a positive attitude towards the technique and highlights the general advantages and durability that the Adobe houses have compared to traditional chicka house. (Balayne & Negasha, 2015) shows an awareness regarding the termite infested chicka houses in the area and argues that the Adobe houses are better as they don’t “rotten from termite infestation”. Because of this they last longer.

**Technical documentations and Observations of Adobe Buildings**

In order to protect the Adobe blocks from moisture and rain in the Habitat project, the traditional Adobe mud plastering was swapped and replaced by chicken wire reinforced cement plastering. A secondary adaptation that was made by Habitat was to reinforce the foundation of the houses with stone and cement mortar, this to prevent capillary suction to occur from the ground soil and to decrease the risk of damages due to flooding during rain seasons (Bedaso, 2015) states that “Houses which are built in this manner are not inferior to other houses which are built with other building materials, i.e. cement and wooden structures, they are strong”.

The big amount of water needed for production causes most of the production and erection of new buildings in the region to be executed during the rainy season (Bedaso, 2015). The local farmers using the technology don’t have the possibility to keep the block in dry storage during production. (Bedaso, 2015) argues this to be a major disadvantage of the technology as floods sweeps over production sites and wash away the newly made Adobe blocks.

In the region it is known that the houses becomes hot during the hot season, because of the corrugated iron sheet roofing and the low-roof building design often adopted in the area (Bedaso, 2015)(Mamo, 2015)(Balayne & Negasha, 2015)(Students tenants Adama, 2015). An adaption would be to build higher walls but this in itself creates a vulnerability, making the walls more exposed to rain, (Ersulo, 2015) tells of an local adaption using bamboo and eucalyptus timber to make an inner roof of the house. An attempt is observed at an inspection (Adama 2)(Balayne & Negasha, 2015), where a plastic foil is used as a ceiling to reduce heat transferred from the roof.

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**Picture 21 - Adama 1, Cement plastering.**

**Picture 22 - Adama 2-2, Additional building made by resident with kitchen, study room and bedroom.**
6.3 Kambaata

6.3.1 Durame

Background and technology

Durame is located at an altitude of 2100 meters, just by the feet of Hambaricho mountain in the Kambaata region. The forest depletion has not yet reached this area, making the population less eager adopting a new construction technology (Grima, L. 2015). This was confirmed by (Ersulo, 2015) who states that the level of awareness of the Adobe technology in the area is not zero, but rather the available timber and possibility of constructing Chicka houses is decisive. Observations show that a majority of the building stock in the region consists of traditional Chicka houses and new concrete buildings. Durame is a densely populated area with much farmland and farmers, (Mathewos, 2015) argues the need of innovative technological solutions to be implemented as a part of the local development. (Grima, L. 2015) points out that afforestation efforts are continuously being implemented by local authorities, involving the local population, but the deforestation seen in other parts of country is starting to become a threat also for Durame. (Grima, L. 2015) also highlights the conflicting scenario that is occurring with the increasing population, requiring land for crops, grazing of cattle and living, effecting the local forest stock. (Grima, L. 2015) argues that Adobe technologies low energy consumption, both during usage and manufacturing, stoves and building blocks, contributes to a sustainable development of both urban and rural areas, as well as he highlights the low-cost aspect of the material. (Ersulo, 2015) states the positive effect on the socio-economical and environmental situation a technical adoption would provide.

Implementation efforts of the Adobe technology were made in 2010, subordinated a research project; “Sustainable Low-Cost Housing – needs, possibilities and attitudes. A project with
focus on the Kambaa Ta Region in Ethiopia” (Hjort, 2012). The project was initiated at Halmstad University in 2002, 4 buildings was erected in Durame 2010 (Hjort, 2010) and they were designed to be used and demonstrated by the local Non-Governmental Organisation (NGO) - Kambaata Lemat Mehaber (KLM)(Hjort, 2012). According to KLM the demonstration buildings were never put to use and their use not demonstrated to the community (Ersulo, 2015). Lack of demonstration has lead to a continued unawareness with the local citizens regarding Adobe technology. According to (Grima. L. 2015) some people believe this to be made from a foreign material “not locally available”.

Attitudes

During the project's duration, dialog with the local government showed of an interest in the implementation of the Adobe Block technology, due to the possible contribution towards environmental protection in the region (Ersulo, 2015). The local authorities have proved their interest through their engagement and a cooperation between the local Women Empowerment office and Ethiopian Evangelical Church Mekane Yesus (EECMY)/Development And Social Service Commission (DASSC) in the area (Tigist, 2015). The cooperation is partly focused on the implementation of wood saving stoves, built with Adobe Blocks. The blocks are produced using the same production method as blocks made for structures.

A survey done in 2012 (Hjort, 2012) gives the following sampled attributes on the mind-set of 40 sampled citizens in Durame.

1. Possible solutions to shortage of housing:
   a. Better possibilities to obtain funding - 2%
   b. Introduction of new, low cost technology - 88%
   c. I don't know - 8%
   d. No Answer - 2%

2. Acceptance of Adobe technology
   a. I don't support the idea - 5%
   b. I support the idea - 93%
   c. I support the idea but I don't think it will be accepted - 2%

Observations show that only minor diffusion of the technology has occurred, even though the sample showed a positive attitude. (Ersulo, 2015) tells of an attitude that “it is an inferior job to use this Adobe”, having a negative effect on the diffusion of the technology.
Technical documentations and Observations of Adobe Buildings

A spontaneous inspection during a field trip witnessed of an implementation done, using the technique for house construction (See pictures “Chicobe Durame”). The building showed an innovative experimentation of the technology, but also points towards a lack of knowledge and technical experience to complete the building in a satisfactory and durable manner, leaving the demonstration as a negative demonstration in the area. The demonstration houses inspected erected in 2010 showed of good durability, although the concrete plastering has released from the structure.

6.4 East Wollega & West Shewa (West)

6.4.1 Ambo

Background and diffusion

The town of Ambo is located just to the west of the capital Addis Abeba, on an altitude of 2100 meters above sea level. The main road from the capital runs through the town, which is experiencing a rapid expansion and modernization. When interviewing (Kesaya, 2015) he speaks about a German missionary he met in 1987, who was working with Adobe locally and initiated him into the technique. He explains how they experimented with hollow core Adobe-blocks and different sizes to achieve an optimized size and heaviness, after which they produced Adobe-blocks at a facility in Ambo. The buildings studied in show of the stones
produces in this facility according to (Kesaya, 2015). (Asfaw, 2015) also mentions a project, which was running 15 to 20 years ago and trained people in the local area. They experimented with different fermentation times and soil mixture, and found out that the most preferable soil for Adobe-blocks contained less than 20% clay, while the mortar could contain up to 50% clay (Kesaya, 2015). The project was eventually moved to Gambella in the far west due to the situation with the government, after which the Adobe technology has slowly faded from Ambo according to (Kesaya, 2015). When speaking to a mason in connection with (Ambo 1) he states that the “Homeless family head house construction project” in 2005 is the only Adobe construction he has witnessed in Ambo. Solid Earth Africa (SEA) is a NGO who aims to promote wood-saving households in Africa. They intend to start an Adobe Business Center in cooperation with local authorities, university and other stakeholders, where training within Adobe technology will be conducted.

**Attitudes**

(Kesaya, 2015) explains his struggle with local authorities approximately 25 years ago, as they would not accept the new technology. He explains that a lack of knowledge and research within the subject made them unwilling to adopt it. The government is according to (Soressa, 2015) trying to reduce the amount of wood used in construction, although the presented substitute is concrete. This was confirmed when (Soressa, 2015) visited the municipality in order to construct a new house, where he got the choice between apartment, townhouse or villa, all of which were only viable through concrete and he would not be assigned a plot otherwise.

A resident of an inspected house mentions the preferable indoor climate, but also that during the Ethiopian civil war during the 90’s people came to their house in order to seek shelter, as bullets didn’t penetrate the walls (Kesaya, 2015). She although states that the general perception of people towards Adobe is still negative, mainly because of its low cost and the fact that it is of mud, resulting in a low status. (Soressa, 2015) also mentions his observation that the technology has been limited to people with low income, limiting the diffusion of the technology.

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The subsidence of the inspected house in (Ambo 2) is described as a result of the insufficient stone-mud mortar foundation and the heaviness of the tile roofing, which was originally fitted by the constructor (Kesaya, 2015). Due to the movements of the house the tiles were also separated, leaving cracks for water to find it’s way through, which further debilitated the construction. In (Ambo 3) Adobe pillars were successfully used to support trusses over large spans, and also had a stabilizing effect on the Adobe extension.

According to (Serveza, 2015) the soil in Ambo is appropriate for Adobe-blocks if you dig 2-3 meters into the ground, although there is an area some 5 km west of town where there is appropriate red soil at ground level.
6.4.2 Nekemte

*Background and diffusion*

Located in east Wollega Nekemte is the central hub for the road network in south-western Ethiopia. At an altitude of approximately 2100 meters the local climate is temperate. When talking to (Kaneu, 2015) he mentions surrounding areas at lower altitude with severe termite problems, where the EECMY synod has initiated projects to limit their extent, although the deforestation surrounding the city has increased their damage on crops and buildings. (Kaneu, 2015) mentions a Norwegian missionary who was active mainly in Idjajii during the beginning of the nineties. This missionary presented the technology to him and helped him spread it throughout the synod and the whole EECMY. (Kaneu, 2015) estimates that between 1992 and 1998, 300-400 Adobe houses were built. This was part of a project where families produced blocks and the church paid for the material, although no follow-ups were made. (Kaneu, 2015) believes that many of them are now torn down due to the urbanisation and modernization.
(Kaneu, 2015) stated that there was a high degree of acceptance towards the technology in the beginning, although it faded out with time as more modern construction technologies were presented. Local carpenter (Dami, 2015) stated that “I almost believe in this technique”, and said that he hasn’t seen anyone building with the technique outside of DASCC’s efforts and engagements.

**Technical documentations and Observations of Adobe Buildings**

In the inspection of (Nekemte 2) a concrete beam wale was observed. It is clear that the concrete beam in combination with the tile roofing provide a hazardous structure. As the heavy weight together with minor leakage between the tiles debilitates the walls, it had caused two gables to collapse on the compound. (Kaneu, 2015) states that it was people trained by DASCC that erected the buildings on the compound.

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**Picture 33 - Nek’empt 1, roof structure resting on columns and Adobe plastering falling off.**

**Picture 34 - Nek’empt 2, cement plastering releasing from Adobe wall.**

**Picture 35 - Nek’empt 2, concrete wale on all walls.**

**Picture 36 - Adobe gable wall collapse, concrete wale remaining and Adobe replaced with timber.**

**Picture 37 – Nek’empt 2, tile roof adding high weight to Adobe structure, causes water leakage due to separation between tiles.**
6.4.3 Idjii

Background and diffusion

Idjajii is located in between Ambo and Nekemte along the main road, and is a small town at an altitude of 1800 meters above sea level. (Alemayehu, 2015) argues that the drill depth to find water 20 years ago was just a couple of meters, and nowadays you need to go to 240-260 meters, which he derives from the deforestation and in turn decreased catchment of water.

In 1986 (Alemayehu, 2015) erected demonstration houses Idjajii 1-2 on the EECMY compound in Idjajii together with the Norwegian missionary, in order to diffuse the technology within the society. The effort also included free-of-charge construction for local villagers, which in return produced the Adobe blocks and contributed during construction. One example (Alemayehu, 2015) mentions is a house for local hotel owner Moulo, who first received a living room free-of-charge and later gave payment for the construction of joining bedrooms. From the observations of (Alemayehu, 2015) the Adobe technology is currently not active in Idjajii, where he argues that the discontinued effort to implement the technology caused the interest to disappear.

Attitudes

The local population showed interest towards the technology during the time Hans Birger Neegård and (Alemayehu, 2015) demonstrated and worked proactively in the village, although the diffusion never reached the pull-market they had hoped. Currently the traditional Chicka method is the most common construction method in the society.

Technical documentations and Observations of Adobe Buildings

In the case of (Idjajii 2) the risks of Adobe was shown when an straw roof was left unmaintained for too long and started leaking, eventually causing the collapse of parts of the wall. The use of columns in Adobe structures was also demonstrated in (Idjajii 2), although for stabilizing purposes and not for load carrying of trusses. The red/brownish clay in the area showed of a comparably low resistance to moisture in comparison with other more pale red/grey color.

![Picture 38 - Idjai 1, reinforced Adobe structure with Adobe block columns.](image1)

![Picture 39 - Idjai 2, circular design traditional grass roofing and reinforcing Adobe columns.](image2)
6.5 West Wollega

6.5.1 Challiya

Background and Diffusion

Challiya is a village, located slightly north east of Aira. The western parts of Ethiopia are not as heavily affected as other parts by deforestation. Farmers protect the trees due to their coffee plantations, which benefit from shade by the trees (Asfaw, 2015). The lower parts of Woina Dega climate zone makes the area vulnerable for termites, which is a major problem in the area, (Kruse, 2015) mentions that in an effort to plant trees executed 1996, thousands of seedlings were destroyed by termites.

Challiya BTS started to implement the technology and push for diffusion in the vicinity of their compound during the 90’s. The technological promotion strategy was based on training, financial and materialistic incentives, given to people during the early adaption of the technology. (Kruse, 2015) notes that some people took advantage of the situation, not only taking the incentives but, as participants, they were erecting their own Adobe homes during the training. Donors restricted the possibility of financial incentives as they argued that the diffusion just occurred because of the given incentives (Kruse, 2015). Challiya BTS continued to support the local users by moving finished blocks from block-productions site’s close to water, to the erection sites. Challiya BTS has then continued to develop and today the vocational BTS have both short- and long- term training running throughout the year, seen in Figure 3.
<table>
<thead>
<tr>
<th>Program</th>
<th>Duration</th>
<th>Orientations</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short time training</td>
<td>1-2 months</td>
<td>1. Appropriate technology (Adobe)</td>
<td>1-3. For inexperienced students. 4. For skill development of local skills in the communities. Requires pre-knowledge.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Pottery</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>3. Basket making</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>4. Advanced wood work</td>
<td></td>
</tr>
<tr>
<td>Long term training</td>
<td>1 year</td>
<td>1. Structural construction, (3m months)</td>
<td>The GCT includes the basics of: plumbing, electrical installations, water construction and spring protection, surveying, bridge construction (production phase), Mud technology (Adobe).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Furniture making (3 months)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. General construction technology, GCT (6 months)</td>
<td></td>
</tr>
<tr>
<td>Government and municipalities</td>
<td></td>
<td></td>
<td>The municipalities is cooperating with Challiya BTS by involvement in setting the curriculums and exams., also gathering students from different parts of the West Wollega region contributing to the diffusion..</td>
</tr>
</tbody>
</table>

The BTS is a non-profit project funded by EECMY/DASCC, making all the training free of charge for the students. At times Adobe blocks are sold to local contractors, the local price for Adobe blocks is approximately 4 ETB/block or 1.5-2.5 ETB/block if you provide the material and only pay for the labor (Asfaw, 2015).

Multiple attempts and efforts to train and inform stakeholders and municipalities from other regions are done by the BTS, as a way of contributing to the continued diffusion. (Asfaw, 2015) states that the BTS can’t receive and serve all requests from people inquiring to enrol in the training. The market demand is there, but as the Challiya project is non-profit there is a lack of finances and capacity, even if the applicants argue their willingness to pay for themselves if they just get in; “we will pay for us” (Asfaw, 2015). Further he states that
enough funds to cover the full costs of a new centre, similar to the Challiya BTS, cannot be claimed from applicants. The recruitment to the Challiya BTS programs is done with the help of the local municipalities in West Wollaga, as they are gathering and sending applicants from the region to the BTS. A system and cooperation with the government is established, which makes it possible for the Adobe technology to spread over a wider area than the vicinity of Challiya (Asfaw, 2015). In order to follow the spread of the technology, Challiya BTS are generally following two principal patterns, the applicant's geographical origin, and from sales of a specific wire that is used for production of Adobe buildings, that is recorded and documented. (Table 4) shows of an increased sale over time (Kruse, 2015).

![Figure 7 - Amount of Iron sold at Challiya BTS, Adobe construction purposes](image)

**Attitudes**
(Kruse, 2015) states “nobody will easily accept something while talking and informing”.. and continues... “They need to see it and experience it so it takes time”. Many contributing factors has been indicated in the region of Challiya, creating attitudes that needed to be considered in order to generate a diffusion of the technology in the region. The regional government seem to have a positive attitude towards the technology, even to the degree that they are promoting the Adobe technology (Asfaw, 2015). In order to counter a fear detected among the population, a fear regarding the durability and risk of burglary due to the mud walls, a demonstration house was erected. The purpose was to give the people a chance to try to demolish it, which they failed to do.
Diffusion is also occurring in the region as people expand and replace their old Chicka buildings with Adobe, using the old for animals and functional buildings (Aswaf, 2015). (Kruse, 2015) states that; "people talk to each other, they mention different reasons of why they think it good and not good”. (Asfaw, 2015) notes that the increased demand of training from Challiya BTS symbolizes the expanding diffusion of technology and acceptance in the society.

(Kruse, 2015) argues that due to the widespread awareness in West Wollega, the technology would diffuse even more if demonstration buildings would be erected that people could see and experience. (Kruse, 2015) notes the possibility for other organizations to implement the technology through demonstration projects; "there would be an option for other projects to move to them, to other places in connection with rural development projects or whatsoever”...and continues…”some may have heard rumours about it or seen it directly so I think it's possible to demonstrate in as many places as possible, and gradually convince people. So there's a high possibility to increase the technology in rural western area”.

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(Kruse, 2015) notes that the first moulds for making Adobe blocks where distributed by EEEMY/DASSC in the 1990’s. The moulds were intended to produce hollow formed Adobe blocks. But Challiya BTS experienced that this structure was not giving satisfactory durability and strength. Adjustments and adaptations of the blocks were made, by filling the hollow parts with Adobe mud-mix, creating a solid block. Experience from the region tells that termite attacks on buildings increases as the natural forest stock is depleted. Infested Adobe blocks do occur, even though in rare occasions (Kruse, 2015). The termites don’t attack the soil mix, but go through reinforcing straws used in the mix if it is not properly fermented. In conclusion a passage is there for the termites to transport themselves to the structural timber parts of the buildings (Asfaw, 2015). Replacing traditional wooden door frames with aluminium and iron is also applied at times in order to prevent termite attacks.

Another example is an adaption made for safety reasons, as people started construct double blocked, interlocking walls (Kruse, 2015). This adaptation has proved of great importance regarding official buildings with longer spans and height i.e. churches and school facilities. Enhanced strength is developed and the risk of deformation and subsidence of the walls is reduced (Asfaw, 2015).

In order to prevent the blocks from rain multiple solutions for plastering have been tried in the area. Cement, cement with chicken wire, cow dung, plastic plastering and lime paint is mentioned by (Kruse, 2015)(Asfaw, 2015). In addition to this (Kruse, 2015) do not recommend the people to use cement plastering, as it is costly, and the adhesiveness between the two materials is low. The cow dung is recommended for plastering if used in combination with some water resistant paint or Adobe plastering.
Adaptations regarding foundations have occurred using stone and cement mortar, as the first lap of blocks can be exchanged with Hollow Core Cement Blocks filled with crushed stones, making the foundation more durable regarding capillarity from ground and floods. Challiya BTS recommend these technical solutions, but availability and affordability limit the adaption. It is also possible to dig down to stable soil, 20-40 cm down, then construct a foundation with Adobe blocks. The soil parameters in Challiya are suitable for this type of foundation and (Kruse, 2015) mention that settling and cracking of walls rarely occurs in this specific region.

In the cases of larger buildings built by Adobe blocks the height of gables increase, providing vulnerability. Roofs sloping at all sides of the building are an alternative, not leaving a high gable (Kruse, 2015). (Asfaw, 2015) notes that placing trees next to the buildings are done as preventive measures in the area protecting the walls. In addition (Kruse, 2015) indicates a need of a declivity surrounding the building to prevent erosion, caused by rain flooding.

The sound properties of an Adobe house are mentioned by (Asfaw, 2015) and (Yishak & Hordajo, 2015), who argued them to be advantageous compared to chicka houses regarding sound isolation. The staff at the Waradale school (Yishak & Hordajo, 2015) have experienced that in Adobe structures, the sound distribution is favourable. But also notes that with many pupils in the classroom it could get noisy due to bad sound absorption.

A problematic aspect of the technology mentioned by (Kruse, 2015) is that the production time needs to be done during the hot season, when there is no rain. The local population in the region seem to have learnt this, but extra effort is needed as either water need to be gathered from distance to production site, or blocks needs to be produced close to water and then transported to the site of erection. Adobe is more adaptable then the Chicka in the case of extensions, as the Chicka walls are more interdependent (Asfaw, 2015). It is possible to bring down a section of an Adobe structure without it affecting the other parts, and then add an extension.

When building the traditional Chicka houses the roof is quickly in place and this is generally seen as an advantage that Chicka has over Adobe. But as the Chicka wooden walls are not often fully plastered straight away, it leaves the houses and the dwellers living in a draft, causing unnecessary health related issues (Kruse, 2015). In this aspect the Adobe is preferable as the walls are from the start tight and protective towards the weather effects.
6.5.2 Billa

Background and diffusion

Billa is located in the Bodji region at 1913 m (Tiptopglobe, 2015), the altitude of the surrounding villages is less than 1850 meter, limiting the termite infestation. (Geechu & Dafa, 2015) confirms the statement of (Kruse, 2015), that less attacks on buildings occur when there are more natural resources, natural food, for the termites. Due to the population growth (Geechu & Dafa, 2015) states that the situation is changing as more land is occupied for farming and dwelling, depleting the forests causing increasing termite infestations in the region. An assessment done by EECMY/DASSC showed that Chicka houses started to get infested by termites almost immediately after the erection, and after 10 years some buildings needed to be demolished due to the extent of damages (Geechu & Dafa, 2015).
The Adobe technology seems to have been in the area for some time, although promotions to generate the diffusion of the technology have been limited. Two local contractors (Dofera, 2015) and (Amansisa et. al, 2015) are active and construct Adobe buildings and ovens for the local population, and state that they were trained by a Norwegian missionary about 15 years ago. This missionary was also active in Zibra and Assosa where (Dofera, 2015) worked with him. When we interviewed (Amansisa et. al, 2015) he was erecting an adobe building, contracted by a local client, in Amu Moagalu outside of Billa. He states that in the Bodji region he has, under private contracts, erected 5 buildings. Natural preservation, comfort and climate-appropriateness, durability and low-cost are given as advantages for the construction method.

The Project Manager of EECMY-DASSC Aira (Tesso, 2015) was trained in Challiya by (Kruse, 2015), and later introduced the technology to the Bodji-synod when working as the Project manager in Bodji. Currently the EECMY/DASSC Bodji-synod is working hard to implement the technology in the region as part of their Integrated Projects under the Western Ethiopia Green Livelihood program. Starting from 2009 the synod has been working with Adobe implementation (Geechu & Dafa, 2015). The first six houses were erected for cooperatives, now they are used as office buildings by the different kebeles. In 2014 six more building were constructed in cooperation with the local kebeles (Geechu & Dafa, 2015).

According to (Geechu & Dafa, 2015) the price of an Adobe house is about half of a Chicka. DASSC gathers local contractors, farmers and municipalities and serve them with technical and practical training for a few days, i.e. how to prepare the soil mix, usage of reinforcing straw’s, technological training, advantages and disadvantages of the technology (Geechu & Dafa, 2015). At times DASSC supports the local farmers constructing with the Adobe technology, with the help of educated local contractors.

**Attitudes**

“I saw it as someone can play with mud”, was the first impression of the Project manager of DASSC in Billa (Geechu & Dafa, 2015) when he first saw an Adobe production in 1993. Today he is leading the implementation efforts done in the area with an understanding of the underlying trajectories and traditions that are affecting the diffusion of the technology in the region. After seeing the technology in action and being able to evaluate and test it he is convinced about the benefits it has for the society he is working to develop. The resistance to termite infestations, general durability and sustainability are strong arguments for his change of attitude. A carpenter informed us of the lack of knowledge prevailing in the area (Dofera, 2015) and (Amansisa et. al, 2015). They also state that the price people are willing to pay is less for an Adobe house, as they think that the contractor have no expenses during the construction.
During EECMY/DASSC:s project, *Demonstration of Mud House technology*, many start off by having a negative attitude towards the technology. (Geechu & Dafa, 2015) notes that many of those who attend, even just as spectators, after the training and erection of the building are convinced of the technology's appropriateness. They criticize their own starting attitude and duplicate the technology for themselves.

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The labour intensive production is seen as a disadvantage in the area. Due to this the community often cooperate during production in order to get water, and to ensure the protection against rainfall of the building during erection (Geechu & Dafa, 2015).

During a visit in a village outside of of Billa, we meet with an Extension Worker from DASSC, (Amansisa et. al, 2015), who highlighted the fact that the technology is beneficial regarding fire. The mud walls are the same Adobe technology used in fuel saving stoves, making them fireproof and durable during a fire outbreak. In an Adobe House, only the roof structure and other flammable part of the construction would burn.

6.5.3 Aira

**Background and diffusion**

Aira is a town located 363 km west of Addis Ababa. At an altitude of 1603 m the environmental conditions are similar to those in Challiya, with large quantities of termites. The diffusion in the district is partly a result of efforts done in Challiya, (Kruse 2015) notes that in the district of Aira and Golisco, a push market strategy is now facing a market pull situation characterized by increasing requests coming to the Challiya BTS program, with people asking for training after having seen and experienced Adobe homes. (Kruse, 2015). As a part of DASSC:s regional development program, Adobe training, implementation and demonstration is done (Tesso, 2015). They facilitate an *Adobe Training Course*, held multiple times each year, with approximately 15 individuals participating annually. During the 21-day course the participants are introduced to a curriculum covering modules of foundation, block production, masonry and production of trusses and roofing. The participants are awarded with an incentive, a toolbox sufficient to duplicate and produce the Adobe blocks for themselves.
One reason that (Tesso, 2015) gives for promoting this technology is that it can generate income to trainees. They prepare the blocks for others and sell them or construct Adobe buildings to generate income. EECMY are often buying locally produced blocks as they are building for demonstration or to their projects, where a price of about 2.5 ETB/Block is estimated. EECMY/DASSC was at the time of the interview constructing Adobe buildings in 14 different kebeles.

The efforts done by EECMY DASSC are mainly focused on the population with a lower social status and less income. According to calculations done by EECMY DASCC the difference between a Chicka and an Adobe house is generally between 3000-6000ETB. This makes the technology appropriate for the lower social strata, as the material is available and affordable. (Tesso, 2015) states that the diffusion has also reached the middle and upper level of the society, which is using it to build extra buildings at their plots and recreational buildings for themselves.

**Attitudes**

(Tesso, 2015) underlines the necessity of this technology as it is beneficiary regarding climate change and deforestation. Also mentioned is the government's need to increase their support and promotion of the technology. “Seeing is believing” is a common expression among the interviewees and (Tesso 2015) states this in connection with his arguments for the need of a demonstration, in order to change attitudes and promote the technology. The attitudes and opinion of the people are very easily set and (Tesso, 2015) shares a story of a village in the district. A farmer started the erection of an Adobe house, he did not have the possibility to finish it. Because of this the house stood uncovered as the rain season came. The walls melted and collapsed and due to this the technology is “dead” in the village. As the attitudes are easily affected by negative demonstrations, (Tesso, 2015) states the need of proper erection. He labels the bad erections as “Building a house of Horror”. Some choose not to use the technology due to the need of water. To counteract this DASSC is assisting with the transportation of blocks from production site to place of erection.

It is stated by (Tesso, 2015); “if you did not accept it for yourself, you can not convince others to use it”, He himself is living in his second Adobe home.
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Picture 51 - Aira Adobe production site, blocks drying.

Picture 52 - Aira 2, HCCB filled with crushed stone on a stone and cement mortar foundation, preventing capillary suction to Adobe blocks.

Picture 53 - Aira 2, mixing of soil, water and straw for mortar.

Picture 56 - Aira 2, construction of Adobe walls.

Picture 57 - Aira 2, additional structural timber over doors and windows.

Picture 58 - Aira 2, wooden columns casted in the walls to improve attachment for doors and windows.
7. General information and viewpoints from stakeholders

In this chapter general information gained mainly through interviews is presented.

7.1 Factors of diffusion:
The differentiated needs of the urban and rural parts are highlighted by (Soressa, 2015), as the sustainable development in terms of housing have different preconditions and requirements in the different parts. It is speculated by (Mathewos, 2015) that 80% of the population will construct their own house, mainly due to the inability of the population in the rural parts to pay others. The diverse cultural climate with different languages, large areas and limited communication possibilities limits the efforts done so far by individuals and organisations to spread the Adobe technology (Soressa, 2015). Although the existing pockets of knowledge about Adobe technology can often be derived from the actions of a specific organization or person in a community, it is in most cases limited to that community (Soressa, 2015). (Öystese, 2015) argues that Adobe is relatively unknown in many parts of Ethiopia, and that mud in general has a low status due to the lack of modernity. This is confirmed by (Soressa, 2015) who further states that an important factor is the introduction of the technology into the curriculums of different educational instances. This is currently very rare and would help spread knowledge as well as improve the status of the technology in the academic context.

The government is focusing on factory produced and more modern technologies, which limits the promotion efforts and support from governmental level (Wakwoya, 2015). The importance of raising awareness in combination with demonstration is highlighted by (Wakwoya, 2015), as this further increases trust and interest of individuals in the technology. Although the demonstration can also have an negative impact if it is conducted in the wrong way, as mentioned in the Aira subcase, seen in chapter 6. Further (Mathewos, 2015) speaks about the importance of public exposure for demonstrations, as well as the continuous efforts within the community. According to (Mandefro, 2015) at the Ministry of Urban Development and Housing, the biggest problem regarding mitigation, in connection with deforestation and environmental issues is cost. This has driven the department to conduct an investigation of cost effective and appropriate construction technologies and materials. A result of the decentralization being conducted in Ethiopia and empowerment of different regions, the department currently is restricted to regulatory work while projects are implemented in the regional level. According to (Tedessa, A 2015) there are low cost housing projects being conducted mainly in urban areas, and specially in Addis Abeba, which are aimed at enforcing the regional policy to sustain the standard of living of every Ethiopian.

Important aspects to increase the rate of adoption are training, marketing, networking and profiling according to (Öystese, 2015). Examples to supply these are introduction and pre-training with local communities, local training groups and community projects. (Öystese, 2015) further highlights the importance of finding credible persons and organizations in the society to help diffuse the technology. The studies of (Holmqvist & Rehnström 1992) states
that scepticism amongst the population to construct with non-traditional materials can be overcome through spreading of information and participation during construction, which leads to increased knowledge and responsibility. An impacting factor according to (Mathewos, 2015) is the increased problems of termites due to deforestation, as this may increase the benefits of Adobe constructions compared to traditional Chicka.

In an interview with (Öystese, 2015) he states that a vast majority of the people in Adobe houses highlight the improved indoor climate compared with traditional construction technologies. (Öystese, 2015) also states that the ability to absorb and release humidity is better than for concrete and burned clay. The low cost and skill level required to conduct maintenance on an Adobe house through plastering is one of the important advantages according to (Tedessa, A 2015). To counteract the heating of houses in lowland areas (Ersulo, 2015) mentions proven methods like building the walls higher or constructing an inner ceiling.

As households can decrease their consumption of lumber through Adobe construction and reduced usage of firewood, their environmental impact will decrease and their economic situation will improve according to (Öystese, 2015). (Wakwoya, 2015) states that a farmer in the western parts of Ethiopia estimated the cost of an Adobe house to be 5000 ETB, while a corresponding Chicka house would cost 10 000 ETB due to the purchase of wood and nails.

7.2 Diffusion in areas not included in the Case study:
(Wakwoya, 2015) explains that the organization DASCC, which is are operating under EECMY have five different development programs, out of which one is the livelihood development program. The livelihood development program includes the food security, climate change, adaption to mitigation, environmental rehabilitation and natural resource management. Adobe technology is promoted as part of the livelihood development program and is implemented in projects where localities and agro ecological aspects are suitable, but has mainly been focused in the western parts of Ethiopia where it is included in almost every project (Wakwoya, 2015). A project that was conducted by DASSC in the south-western parts of Rift Valley was forced to change constructional method due to the unsuitability of the local soil, as it was not possible to produce reliable Adobe blocks from it (Wakwoya, 2015).

In far western Ethiopia, in the town of Gambella, there was a research project conducted in the the 90’s aimed at introducing the technology (Kesaya, 2015). The project included a multitude of different experiment houses, including a two-storey hybrid house built with a concrete framework structure and Adobe walls according to (Kesaya, 2015). Further (Kesaya, 2015) states that the acceptance towards Adobe was complete within the community after 3-5 years, and derives it from the low development and communication possibilities in the region at the time, which made Adobe to be seen as a modern technology.
At Selam Technical and Vocational Center in Addis Abeba an attempt was made to commercialize Adobe blocks in the early 1990’s, although it was found that no market existed (Bengt, H et al 2010). In the Rift Valley Adobe constructions have been observed in Dera, Langano, Metehara and Meki, where there is a shortage of constructional timber (Bengt, H et al 2007). When the BTS in Challiya approached the building department in one of the major cities in the region, Gimbi, to assist with the implementation of Adobe technology into the local vocational training centre, it did not work out although interest was expressed (Kruse, 2015).
8 Discussion, Conclusions and Recommendations

8.1 Innovation; analysis, discussion and conclusions

_Coupling model of innovation_

Seen in the studied cases are that the project based conditions of the Adobe construction market, and the construction market in general, have an effect on the diffusion and rate of adoption of the technology. The West Wollega case study shows of a continuous effort of implementation, creating a possibility to learn from previous experience and apply the lessons in new projects. It is crucial for the technological innovation of Adobe technology to diffuse and for the market to adopt it. A resource-based perspective is emphasized by observations in the case, where adoptions, experiences and knowledge is continuously implemented and imparted by stakeholders as a part of their ongoing training and Adobe construction projects with the local market actors.

The opposite is observed in the Kambaata case where knowledge in form of a resource exists, but the implementers have failed to demonstrate and educate people in the technology even though preconditions are there. When the market actors in the area try to adapt the technology, without any understanding and experience, they are at times creating a negative demonstration that limits further diffusion instead of generating it. The same case shows that for Adobe technology (stove production) the market, with the support of a technological push, cooperation with local municipalities and legislators, onsite demonstration and training with a resource-based approach, can provide the basis for a market based demand. The ability of the stakeholders to interpret the market is either stimulating or hindering the diffusion of the Adobe block houses.

The Harrari State and the Central Rift Valley show that market based diffusion can occur as the market environment is changing. In these cases due to natural resource depletion, consisting of a high rate of deforestation in the area causing the timber to decrease and prices to increase. This forces the technological trajectory to change and people to adapt. An increased demand for sustainable construction technology is developed.

_Incremental- or Radical- innovation_

The Adobe housing technology in Ethiopia, seen in an innovation perspective, can be of both an Incremental and Radical kind. In areas like the Harrari state, the local construction method from ancient times is based on stone and mud in the walls, and timber as beams in flooring and roofing. As the Adobe technology is to a large part based on ancient and current construction knowledge, it can be described as incremental. At the same time the technology differs from traditional methods as it uses no other material than mud for load-carrying purposes and offers a new approach with lower threshold for the population to construct houses. The cost of an Adobe house is less than other available construction methods, which
formulates a new approach and makes the innovation Radical. In areas like West Wollega the construction technology has made a large impact and changed the trajectory, where a high level of diffusion has occurred.

**Evolutionary Innovation Perspective**

The trajectory of the studied Ethiopian cases seems to be hard to change. Traditional thinking is observed in all studied cases, having a big impact on the selection process regarding construction technology on a micro level. Partly due to the safety, replication is preferred rather than the uncertainty of invention. The economical actors, such as municipalities, R&D organizations and local contractor are at time promoting the technology in an interplay situation. This is seen in West Wollega where a high level of diffusion has occurred. The macro trajectory is formed by the small micro decisions, decisive for the general attitude and diffusion. Negative attitudes have been noticed from the municipalities in many of the cases. The argument is that the Adobe technology is out-dated and insufficient. This is causing a split in attitudes spread about the technology, preventing an adoption of the technology, as well as preventing a fruitful interplay between the macro and micro level actors on the market to occur. In Adama and Ambo the diffusion has partly been stopped due to negative attitude of the municipality towards the technology, denying continuous implementation efforts by local stakeholder. Although in Ambo new implementation efforts and cooperation between macro and micro stakeholder are occurring, with a possibility to change the technological trajectory in the district. The macro players such as municipalities and governmental offices are interdependent with the academic sector, which is contributing to defining a technologies modernity and sustainability in academic scripture and reports. Diffusion and acceptance of the technology is expected to occur when Adobe technology is included in the curriculum of the local universities and academic instances, not observed today. In West Wollega the macro players of the market have a big effect on the evolution of the diffusion and adoption of the technology, as they are supporting the implementing stakeholders. When the interplay works the macro actors can radically change the trajectory seen in the micro selection process.

**Diffusion of innovation**

The study shows of varying knowledge surrounding the technology, highly dependent on local conditions and traditions. The Harrari State case shows of a long history of Adobe construction and depleted resources, while in areas where forests are still available, like in the Kambaata region the technology has been overlooked and knowledge is limited. The lack of knowledge shows of an often sceptic judgement of the technology, as many preconceptions surrounding the technology is mentioned by people with limited and case specific knowledge. This shows that collective diffusion decision is adopted in the Harrari State, where the increased prices of lumber have forced the market towards the Adobe technology. The cases of West Wollega and Kambaata shows of an optional decision, where West Wollega have chosen to adopt the technology and Kambaata haven't, although both areas still contain forests.
The cases of East Wollega and West Shoa show of a depleted knowledge, faded with time as implementation efforts were halted. This validates the importance of continuous efforts. As seen in Challiya, the technology has diffused not only in the vicinity, but further to Aira and Billa and Zwai. Implementers generally adopt demonstrations of the technology, in order to confirm its suitability and sustainability. The partly collapsed houses in Idjajii and Nek’emte show of demonstrations that impact the accumulative diffusion and rate of adoption in a negative manner. In general the negative demonstrations have a much larger impact than positive ones, as the information diffuse to a larger crowd and enhance preconceptions.

The social factors and systems in Ethiopia provide several independent societies with limited knowledge exchange. The multilingual situation, economic circumstances, limited infrastructure, decentralized government and vast geographical areas limit the diffusion of innovations. The promotion efforts of the Adobe technology in Ethiopia are currently done by NGO’s and R&D organizations. The NGO’s and R&D organizations are run by donations and their commitments are often decided centrally, where minor setbacks can disrupt their commitment to a specific technology. This is seen in the case of Habitat for Humanity who chose to return to the traditional Chicka technology in their relief programs, partly due to the resistance towards Adobe technology from municipalities in Adama.

The Ethiopian population in general has limited economic means, which limits the diffusion. The innovators and early adopters are often described as persons with economic stability and means to experiment. This explains the early threshold to overcome before the early and late majority can be addressed, whose preferences are more aimed at sustainability and security. As buildings have a long time perspective it requires a long span before the technology can diffuse, and require substantial benefits for the majority to adopt a new technology. The majority will also look for more trustworthy sources of information and actual demonstrations before ensuring themselves of the validity of the technology.

Relative advantage
The Adobe technology offers a low threshold regarding availability, affordability, simplicity and sustainability. If maintained and constructed correctly, an Adobe structure becomes very durable and can outlive the traditional Chicka structure, which is weak to termite infestation. The low contribution to the natural resource depletion is in favour of the Adobe products. The Adobe structure can be vulnerable since the load carrying parts are susceptible to moisture and require knowledge how to protect.
Compatibility
Ethiopia is undergoing a rapid urbanization where mud construction is fading from larger cities, and is looked at with scepticism as concrete has taken the place as the modern and more durable technology. The need for Adobe technology is although obvious especially in rural parts, where economical means are limited and prices of lumber have increased. The main competitor is the traditional Chicka technique, which is partly constructed from mud, and makes the Adobe technology consistent with existing values. In some parts of the Harrari State the choice has not been an option due to the lack of lumber, creating the need for a low-cost and available construction material.

Complexity
The Adobe technology is based on mud, a material that has been used in the whole of Ethiopia for centuries to construct houses. Making of Adobe blocks is the only part that differs from existing building technologies, as the masonry work when erecting walls is the same as when using HCCB:s. This provides a technology that consists of adaptations of different existing building technology that is easy to learn.

Trialability
The Adobe technology offers a range of different possibilities to customize as shown by the case studies, including different plastering, foundations, construction shapes and roofs. In Gambella a hybrid house was erected, and in Challiya the possibility to rearrange and open parts of walls was mentioned. Another example is the construction of lumber saving ovens, bookshelves, beds and sofas with the Adobe blocks.

Observability
As the diffusion of the technology varies, the observability does so as well. A common promotion strategy adopted is erection of demonstration buildings. In the Harrari State, West Wollega and central Rift Valley the technology represents a recognizable part of the existing housing stock and Adobe blocks for sale are a common sight, making it observable. In other areas like East Wollega, West Shoa and Kambaata the technology is scarce and only visible in rare cases, halting the further diffusion of the technology.
8.2 Ethiopia; conclusions and recommendations based on a holistic perspective

The simplicity of the Adobe technology, combined with its possibility to enhance the durability proves the appropriateness that Adobe block houses can provide. Due to clear signs of how Ethiopia is affected and treated by the Climate Change, this is of importance for the possible mitigation of the consequences for the country. The majority of the population is found in the lower parts of the social and economic section in the society, which limits the eagerness to experiment with new innovative technologies. Due to the limited information diffusion the main reasons to accept a new technology seem to be experience and forcing natural conditions.

Demonstration and promotion from interplaying, implementing macro stakeholders are of great importance. Clearly seen in the study is how a demonstration, purposely or not, can hinder or fuel a technological diffusion, and the negative ones seem to have a stronger impact than the positive. Ethiopia’s market environment for a diffusion of innovation is negatively affected by the governmental decentralized structure, leaving the regions separated and isolated, aggravating the cross-border diffusion to spur. Due to the large capital demands of housing the government is unlikely to intervene in a large extent to promote the Adobe technology, as higher efficiency in form of decreased deforestation can be reached through other measures, for example by introducing and promoting fuel saving stoves. There can be dangers when subsidizing building technologies as it might dislodge the natural trajectory both at implementation and when the subsidizing ends. In this case a trajectory dependent on the subsidizing is not a desired result. The introduction of the Adobe technology into curriculums of handcraft schools and general research at the Universities are efforts that would validate the technology and increase its status. If more accurate training and general knowledge is provided the threshold to introduce the technology into societies would be lowered, opening for further diffusion.

The cultural aspect, with its multilingual and multi-tribal situation, is complicating the promotion and natural diffusion of the technology. This leads to an enhanced need of a purposefully developed marketing and promotion strategy, adapted to different regions and social situations, taking the local technological trajectories in consideration. Currently the technology is seen as a low-cost option, in many cases inferior to the traditional Chicka technology. In turn the adoption of Adobe technology requires substantial benefits for it to be a viable option for Ethiopians. As seen in many implementations the NGO’s and R&D organisations have often focused on the poorest part of the society, resulting in a branding of the product as ‘low-cost’. This hinders the diffusion into middle- and high-income households, leaving the low-income households that construct houses themselves and with a basic and simple design, making them less attractive.
8.3 Follow up studies
All recommended follow up studies are preferably done in a local context, as it contributes to a local knowledge diffusion and in-house documentation.

Compendium; Adobe construction in Ethiopia
- A documentation where data, adaptations, evolutions, production -risks and -methods of the technology is made publicly available and simply coded for a simple audience to use. Gathering experience and unwritten knowledge from the implementers in the entire country. This is recommended as it would be important in order to secure positive development and demonstrations of the Adobe technology, limiting negative demonstrations to occur.
- A comprehensive analysis of the appropriateness of different soil types that occur in Ethiopia. Evaluating and documenting the properties and durability of different soil types, when composed into Adobe blocks.

Others
- A comprehensive LCA of the Adobe building technology covering extraction, processing, production and transportation of materials. This would elucidate the environmental impacts of the technology.
- A stakeholder analysis that maps out the different stakeholders on a macro and micro level, and their role and interest in the diffusion of the technology.
- The evaluations of hybrid structures involving Adobe, for instance concrete column structures with Adobe as walls. Resulting effect on slab and foundation elements due to the fact that Adobe is a high-density building material. Comparing Adobe blocks to HCCB’s. Covering an analysis of the shrinkage due to temperature change in the Adobe blocks compared to other building materials and the effects on structural parts in combination to hybrid structures.
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**Interviewees**

Alemayehu, Melkamu (2015); Interview in Ambo 2015-02-16 - Working with community based child development in Ambo, he has for many years worked with Adobe constructions in Idjaji. He is also engaged with SEA.

Asfaw, Jote, (2015); Civil engineer and coordinator at Challiya BTS, Interview and notes from Challiya Building Trade School, 2015-02-19

Amansisa Asafa , Walgas Balins and Kitilla Dole,(2015); Site interview in Amu Moagalu outside of Billa 2015-02-20

Balayne, Workie & Negasha, T’isigie. (2015); Adama Habitat village dwellers and owner of two Adobe houses, Interview during an inspection at site, 2015-02-07

Bedaso, Gobane, (2015); Representative Habitat For Humanity in Adama/ Nazareth, Personal Interview in Adama, 2015-02-07

Dofera, Dereji, (2015); Masonry and carpenter using Adobe in business, Personal interview in Billa 2015-02-20

Dami, Zackarias (2015); Notes from Nekemte 2015-02-17

Ersulo, Adinew, (2015); KLM Chairman Durame, Personal interview in Durame 2015-02-08

Geechu, Sanbata & Dafa, Solomon, (2015); Personal interview in Billa, 2015-02-20. Sanbata is GED and Solomon is a Project relief manager at EECMY DASSC Bojji synod.

Grima, Legesse, 2015, Agricultural extension worker - EECMY DASSC , Personal interview in Durame, 2015-02-09

Grima, Ruba, 2015; Carpenter and handyman active in Alemmaya & Harar. Personal interview in Alemmaya 2015-02-02

Kaneu, Debela (2015); General Director of DASSC’s Nekemte synod, Notes from Nekemte, 2015-02-17

Kesaya Deribe, (2015); Interview in Ambo, 2015-02-17

Kruse, Herman, (2015); Executive Director at Challiya BTS (Building Trade School, Hermannsburg Mission and Evangelical Lutheran
Mission, Personal Interview in Addis Abeba, 2015-03-01

Mandefro, Getachew (2015); Ministry of urban development and housing, construction material state department. Personal interview in Addis Abeba 2015-01-30

Mamo, Zagay, (2015); House inspection and interview in Adama Habitat village 2015-02-07, Adam Building 1

Serveza, Kokoni (2015); Interview in Ambo 2015-02-15

Soressa, Kebede, (2015); Head of Consultancy & Community Service at Ambo University, Interview in Ambo 2015-02-16

Students tenants Adama, (2015); Spontaneous House inspection and interview in Adama, 2015-02-07, Adama building 3

Tesso, Bona (2015); Project Manager at EECMY / DASSC in Aira. Personal interview in Aira 2015-02-18.

Wakwoya, Abeya (2015); DASSC - PME & QM program director. Personal interview in Addis Abeba 2015-01-26

Yishak, Keneni & Hordajo, Regessa Saketa,(2015); Keneni is General Director of Wirtuchalliya school in Waradale, Saketa is the Vice Director. Personal interview in Waradale 2015-02-19

Öystese, Brigt (2015); Chairman of Solid Earth Africa & building contractor. Personal interview 2015-03-27

Internet:


Tip top globe (2015); http://www.tiptopglobe.com, [2015-04-28]


10. Attachments

Content

➤ A1 – Interview questioner - Templet
➤ A2 – Inspection report’s and housing stock design
A1 – Interview questioner - Templet

A: Stakeholders

A1. Which are the most crucial areas for Ethiopia, in regards to reaching a sustainable construction development?

A2. What governmental programs are there to promote a sustainable construction development?

A3. Do you know about any regional programs?

A4. Do you see the Adobe technology as a part of the sustainable development in Ethiopia? If yes, in what way?

A5. Which measures do you believe would make the Adobe technology spread?

A6. Do you see a possibility for Adobe to spur the national economic growth? And if so, how?

A7. What development opportunities do you see for the Adobe technology?

B. Technical aspects

B1. What aspects are important when building an adobe construction?

B2. Which technical advantages do the Adobe technology possess compared to other constructional methods?

B3. Which technical disadvantages do the Adobe technology possess compared to other constructional methods?

B4. How is the workload and expenditure of time compared to other constructional methods?

B5. How cost effective is the Adobe technology compared to other constructional methods?

B6. How does the Adobe technology measure in regards to implementation of technical installations?

B7. What technical solutions are there to counteract the weaknesses of Adobe technology?

B8. If we want to install a kitchen or fix something to the wall, are the Adobe blocks strong enough to keep it up?

B9. How do you look at the possibility of a hybrid house using Adobe?

B10. Do you know of any ways of treating the outside to make it more durable to rain and other weather conditions?

B11. What can you do to secure an Adobe house against termites?

B12. What can you do to secure an Adobe house against seismic movements?

B13. Is there any difference in earthquake resistance between a hydroform block or other blocks, since it doesn’t use mortar?
C. Geographical/geotechnical aspects

C1. Which geographical aspects are important to consider when choosing a site to construct an Adobe house?

C2. Which geotechnical aspects are important to consider?

C3. Are there any special systems for constructing foundations for Adobe/CSSB houses?

D. Indoor climate and usage aspects

D1. How is the indoor climate in an Adobe house compared to other constructional methods, in regards to:
   - Air quality
   - Indoor temperature
   - General comfort

D2. How do you think that Adobe is satisfying your requirements and needs regarding indoor activity and usage?

D3. How are the sanitary conditions in an Adobe house compared to traditional building methods?

E. Esthetical aspects

E1. What was your first impression when you saw an Adobe House?

E2. What do you think about the design of the Adobe Houses compared to other construction methods used?

E3. In the eyes of your community how is the Adobe house looked at, what is the status?

F. Socio-Cultural aspects

F1. Do you know how this construction is built?

F2. What is your general perception of the Adobe technology?

F3. Would you consider building your next house with Adobe?

F4. Would you recommend your friends to use the technique?

F5. What have you heard about Adobe?

F6. What is your personal perception and thoughts about the Adobe technique?

F7. Why is/isn’t the Adobe technique being used in this Specific area/ region?

F8. Why has not the technique spread to neighboring regions?

F9. How is the Adobe technical solution viewed from a traditional and Cultural perspective?

F10. Do you see a potential market in the production of Adobe blocks?
F11. Which impact has the Adobe technique had on your financial situation?

**G. Marketing and promotion**

G1. Which segments of customers do you target (level of social status, economical ability, area of residents)?

G2. How is the different segmentations specifically targeted?

G3. Are there any specific strategies that you are using (also differences between segmented groups)?

G4. How are you promoting the blocks?

G5. How is the blocks branded/presented to the segmented target groups.
   - R&D product or a product better and more advanced/high class functional product.

G6. What is your future expectation regarding this specific product.

**H. New business aspects**

H1. How did you come in touch with this type of products?

H2. How long have you been producing/constructing with these products?

H3. What has been the command of your target group/target market?

H4. What has been the result on your business because of these blocks?
   - Finance
   - Personal
   - Expansion

H5. What is your future perspective of these blocks?

H6. Do you think it’s hard or complicated for a person living in a village to start a business or company using this technology?

**I. Completing questions from Sea.**

I1. How much did the hose cost you to erect?

I2. What makes a house look nice to you? Inside/outside.

I3. Why did you choose to build with Adobe and not a chicka house?

I4. Do you have a wood saving stove installed in your home?

I5. Who constructed your home?

I6. Does anyone in your household have any smoke related health issues?
Note: In all cases the windows and doors are not in scale!
<table>
<thead>
<tr>
<th>Inspection Report - Allemay East</th>
<th>Inspection Report - Allemay East</th>
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**Additional Information:**
- Inspection by [Name]
- Date: [Date]
- Building: Allemay East

**Inspection Report - Allemay East**

- Condition:
  - Good
  - Fair
  - Poor

- Material:
  - Wood
  - Metal

- Description:
  - Cracks
  - Peeling paint

- Recommendations:
  - Repair cracks with sealant
  - Paint affected areas

- Follow-up:
  - Inspection every [interval]
**Inspection Report - Duration 2**

### General Information

- **Date of Inspection**: [Insert Date]
- **Description of Location**: [Insert Description]
- **Condition**: [Insert Condition]

### Electrical System

- **Outlet**: [Insert Outlet]
- **Circuit Breaker**: [Insert Circuit Breaker]
- **Voltage**: [Insert Voltage]

### Structural Features

- **Roof**: [Insert Roof Type]
- **Wall**: [Insert Wall Type]
- **Floor**: [Insert Floor Type]

### Mechanical Systems

- **Heating**: [Insert Heating System]
- **Cooling**: [Insert Cooling System]
- **Ductwork**: [Insert Ductwork System]

### Plumbing Systems

- **Water Supply**: [Insert Water Supply System]
- **Waste Disposal**: [Insert Waste Disposal System]
- **Plumbing Fixtures**: [Insert Plumbing Fixtures]

### Detailed Inspection Notes

- **Overall Condition**: [Insert Overall Condition]
- **Recommendations**: [Insert Recommendations]

---

### Diagram

[Insert Diagram]

---

### Graphical Representation

[Insert Graphical Representation]
### Inspection Report - Ambo 22

<table>
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<th>Remarks</th>
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<tbody>
<tr>
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<td>Door frame and glass in good condition.</td>
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<tr>
<td>Window</td>
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<td>Window is intact.</td>
</tr>
<tr>
<td>Roof</td>
<td>Condition 3</td>
<td>Roof is in good condition.</td>
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#### General Location Notes

- Date of inspection: 03/27/17
- Area: 123 Main St.
- Inspector: John Smith

---

### Equipment List

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<td>Plumbing System</td>
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</tr>
<tr>
<td>Heating System</td>
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</tr>
</tbody>
</table>

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### Key Measurement

- Height: 2.3m
- Width: 1.8m
- Depth: 0.9m

---

### Conclusion

The inspection was conducted by an independent professional. All major systems were found to be in good condition. Further maintenance is recommended for the electrical panel and plumbing system.

---

*Note: The diagram shows the layout of the equipment and areas of inspection.*
### General Information

- **Report Title:** Inspection Report - Waradale 2
- **Date:** Unknown
- **Location:** Unknown
- **Prepared by:** Unknown
- **Reviewed by:** Unknown
- **Approved by:** Unknown

### Door Frame

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### Window

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</table>

### General Condition

- **Structure:** Complete and sound, no visible defects.

---

**Note:** The document includes detailed descriptions and diagrams for various parts of the building, but the specific areas and conditions are not clearly visible in the provided image.
Kaleb Ström
(B.Sc) Construction engineering -
International construction
management and production.

Pontus Petersson
(B.Sc) Construction engineering -
Construction management and
production.