

A close-up photograph of a fish being cooked in a black metal pan. The pan is placed over a fire burning in a traditional outdoor stove made of light-colored stone or concrete. A hand is visible on the right, holding a long metal rod that is used to turn the fish. The background is dark and out of focus, with some small lights visible.

Reality Studio 2026
Chalmers University of Technology

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FIRE AND FISH

Working Conditions at Dunga Fish Market

ABSTRACT

Dunga Beach is a lakeside village just outside of central Kisumu, along the shore of Lake Victoria. Its culture is deeply connected to the lake, an important part of it being the fish. Caught from the lake, fried at the fish market and served at the many restaurants, all at Dunga Beach.

The study focused on the working environment at the market. It resulted in the realization that it could be greatly improved due to the demanding conditions that the women frying the fish face everyday at work. The challenges relate to high temperatures, polluted air and a shortage of water.

As a first step in the direction of a more comfortable working environment, a prototype was built with the intention of improving the air flow around the firewood stoves that are used for frying. It works by modifying the existing roofs, creating an outlet for the smoke. Furthermore, it makes use of rainwater, leading it to a tank where it can be collected for use.

The field study was carried out with the valuable support of the people at DECTTA as our local mentors, the eco tourism association at Dunga Beach.

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1 BACKGROUND

This section gives an introduction to the project and the aims behind it, as well as the course for which it was done. Further, it shows the timeline, showcasing the phases that went into the project before, during and after the field study. Lastly, the context of the field study is presented, giving the reader insight into the place and its culture.

1.1 INTRODUCTION

Reality Studio

Reality studio is a project course offered by the department of Architecture and Civil Engineering withing the masters program Architecture and Planning Beyond Sustainability at Chalmers University of Technology in Gothenburg, Sweden. The course took place from March to June in 2026 and comprises 15 credits. Five weeks of the course are conducted as field-studies. The aim of the course is for students to experience new contexts and gain insight into other cultures and practices. The overall goal of the studio is to develop design solutions that are adapted to the context and support dignified human everyday life. The studio is performed in line with UN's 17 sustainable development goals.

Students

Working with this project were three Industrial Design Engineering students from Chalmers University of Technology.



Our Project

The initial scope of our project was to work with the use of firewood at Dunga Beach. The firewood presents many challenges, all from shortage due to deforestation, problems in the supply chain because of floodings and poor infrastructure, to challenges in usage such as smoke and escaped heat (personal observation, 2026).

The project was shaped during the field-studies when needs and opportunities were discovered. During the project, different directions were explored such as looking into alternative energy sources or how to create more efficient stoves, but it ultimately landed in focusing on improving the working environment for the women who fry fish at the fish market.

Because of the limited time with five weeks of field-studies, the project focused on what can be done there and now to support dignified human everyday life, and the most urgent and addressable needs were chosen to achieve this.

Project Aim

Our project aim was to understand the local context and needs, drive positive change through learning and participation and lastly to support the sustainable development goals.

The desire was to create something that can be an improvement of the current situation but also act as a spark for improvement across the whole fish market. We wanted to design with the users, meeting their needs where they are right now.

UN's 17 Sustainable Development Goals

The United Nations Sustainable Development Goals has served as a guiding framework for this project's decision-making.

3: Good Health and Well-being

The project aims to reduce smoke levels in the air to improve health conditions. It particularly focuses on target 3.9: to reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination (United Nations, n.d.).

7: Affordable and Clean Energy

Goal 7 has influenced the project through the investigation of alternative energy sources.

8: Decent Work and Economic Growth

The project focuses on promoting decent working conditions, addressing target 8.8 that focuses on protecting labour rights and promoting safe and secure working environments.

Glossary

- jiko = stove
- fish monger = fresh fish vendor
- mama = woman who fry fish
- fundi = craftsman
- erokamano = thank you



1.2 TIMELINE

- Preparation
- Literature seminars
- Logical framework matrix (see appendix A)

Pre-field study at Hammarkullen

23/3 - 2/4

- Learning more about the way of Dunga Beach
- Interviewing about energy sources
- Mapping stakeholders

Exploration

WEEK 2

WEEK 1

Travel to Kisumu

- Getting adjusted to life in Kisumu
- Boat ride on Lake Victoria
- Guided tour in Dunga Village

WEEK 3

Orientation

- Cooking fish on jikos
- Observations
- Interviews
- Workshop with intended users

- Ideating
- Brain drawing
- Consultating with DECTTA
- Modeling
- Buying the materials
- Start building the prototype

Ideation and building

WEEK 4

Travel to Sweden

9/5 - 11/5

WEEK 5

Continue building the prototype

- Finish building the prototype
- Evaluating with the users
- Handover to the local mentors

12/5 - 4/6

Post-field study at Chalmers

- Creating booklet
- Creating poster for exhibition

1.3 CONTEXT

Dunga Beach in Kisumu, Kenya

Dunga is a lakeside village situated approximately 10 kilometers south of central Kisumu, the third largest city in Kenya, with an estimated population of around 540,000 as of 2026 (World Population Review, 2026). Kisumu is characterized by its proximity to Lake Victoria, a feature that strongly influences the region. In Dunga, the presence of the lake is particularly pronounced, shaping cultural practices and economic activities. The local economy is largely dependent on fishing and aquaculture, and the culture is closely tied to the lake and its resources. The population is predominantly from the ethnic group Luo, whose primary language is Dholuo, although both English and Swahili are widely spoken (personal observations, 2026).

Dunga Beach, located along the shoreline, functions as the central hub of economic and social activity within the village. The area is characterized by a high concentration of small-scale businesses, the majority of which are linked to fishing. Both traditional fishing and aquaculture contribute to the local supply of fish, with tilapia being the most common type of fish. Other species include Nile perch, mudfish, and omena, a small sardine-like fish that is usually sun-dried and then fried. The fish is sold locally at the fish market and in the restaurants, but is also transported to central Kisumu and further distributed to major urban centers in Kenya, including Nairobi and Mombasa (personal observations, 2026).

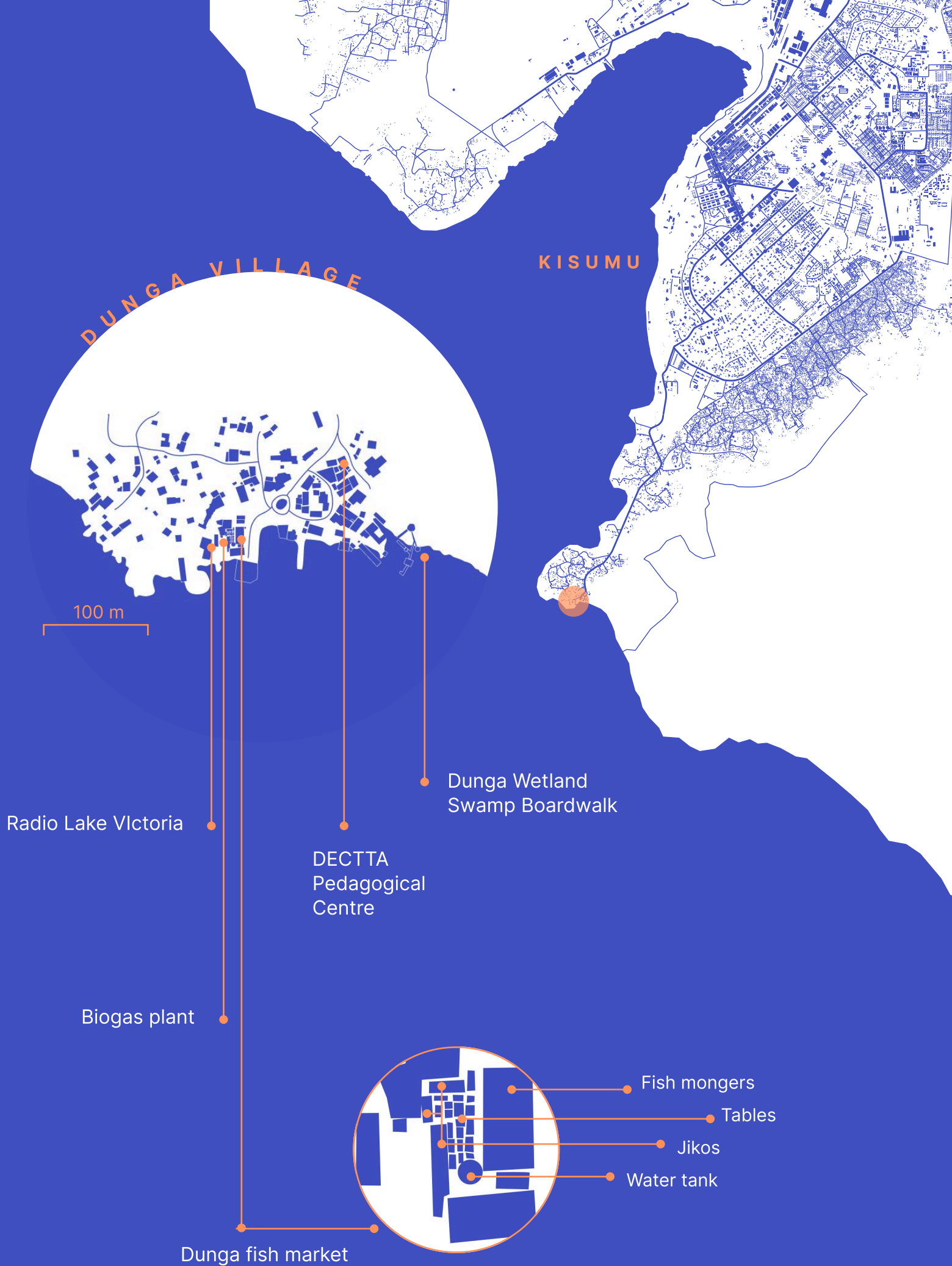
The beach area is a dynamic and densely utilized space, characterized by constant activity. Approximately 18 restaurants operate along the shoreline, alongside a large fish market offering both fresh and fried fish. It is thereby the workplace for hundreds of people. Dunga Beach is also a site for eco-tourism where visitors can go on boat rides on Lake Victoria and see the lake up close from the boardwalk (personal observations, 2026).

The Use of Firewood in Kenya

Firewood is the primary source of energy for cooking and heating in most rural households in Kenya and is also widely used in institutions and small industries (Stockholm Environment Institute [SEI], 2014). While it plays a crucial role in meeting energy needs, its use is associated with significant environmental and health challenges.

Kenya's forest cover, estimated at 5.9%, is insufficient to meet the demand, and unsustainable practices such as illegal harvesting hinder natural regeneration (SEI, 2014). Firewood collection is predominantly carried out by women and children, who are also most affected by household air pollution from inefficient stoves, such as the three-stone stove. The use of biomass fuels is the second leading risk factor for ill health in developing countries (SEI, 2014).

Efforts to improve sustainability are constrained by limited research, weak policy coordination, and poor alignment between technologies and user needs. Addressing these challenges requires a coordinated, cross-sectoral approach that includes sustainable forest management, promotion of agroforestry, adoption of efficient stoves, and stronger institutional frameworks.







2 METHODOLOGY

Section 2 provides a clearer view of the process and timeline during and after the field study. Furthermore, it goes into detail about the methods that were used within each of the phases.

2.1 PROCESS

Phase 1 - Discover the Context

-
- Activities
- Observations
- Interviews
- Workshop 1: Clean with the community
- Workshop 2: Cook fish together
- Workshop 3: Pain points
- Workshop 4: Dream scenario
- KJ-method

-
- Output
- Stakeholder map
- Energy sources
- User needs
- Design principles

Phase 2 - Design

-
- Activities
- Brainstorming & mindmapping
- Sketching
- Small scale models
- Prototyping and testing

-
- Output
- Ideas
- Design proposal

Phase 3 - Prototype

-
- Activities
- Get materials
- Workshop 5: Building

-
- Output
- Final prototype

Phase 4 - Evaluate

-
- Activities
- Contextual inquiry with users
- Hand-over with local mentors

-
- Output
- Feedback
- Insights
- Future ideas

Phase 5 - Post-field Study

-
- Activities
- Create a booklet
- Create poster
- Reflect on future

-
- Output
- Booklet/Report
- Poster
- Masterplan

2.2 METHODS

Observations

Observations were made in order to better understand the context. This included a boat ride organised by DECTTA and walking around the site as well as participatory observations. Participatory observation is a qualitative research method where researchers immerse themselves in a group or a social setting, actively engaging in daily activities while observing the behaviours of others (McKechnie, 2008).

Interviews

As part of the user studies, different types of interviews were conducted, including structured, semi-structured and informal interviews.

In addition, the walk-and-talk method was frequently used throughout the project to facilitate more natural conversations in the participants' everyday environment, as well as contextual inquiry.

Semi-structured Interviews

Structured and semi-structured interviews were conducted to gather specific information while also allowing participants the freedom to elaborate on their experiences and perspectives. This combination enabled consistency across interviews and flexibility to explore different topics in greater depth. Informal interviews were carried out continuously throughout the field study.

To gain more knowledge about the different types fuel, we interviewed firewood vendors, charcoal vendors, and managers of the solar and biogas plants. To understand the working conditions when using a firewood jiko, we interviewed hotel owners, fish mongers and mamas at the market. This gave us a deeper understanding of what it means to use a jiko and to be a mama at the fish market. To understand how jikos are made, we interviewed a jiko fabricator. This gave us valuable insights into what it means to construct a new type of jiko. We also interviewed managers at the biogas plant and in the solar hub, to understand more about the energy resources at Dunga.

Walk-and-Talk

The walk-and-talk approach involved engaging with the participants while moving through their working environment. Walking-and-talking is used to understand the spatial arrangement of a place (Architecture Sans Frontières UK, n.d.). This method enabled discussions to be connected directly to specific locations and situations, helping the participants reflect on their experiences in context and revealing insights that may not have emerged in a more formal setting.

Contextual Inquiry

This is a qualitative user-centred research method where the interviewer observes and interviews users in their context, as they perform daily tasks. This method helps unveil hidden needs, workflows and pain points that users often fail to mention in more formal interview settings (Flaherty, 2020). This method was used in the orientation and evaluation phase of the project, for example through conversations with the cooking mamas while they were scaling and preparing fish at the fish market.



Workshops

Five workshops were conducted during the field study. The first two were participatory observations with the local mentors. Workshop three and four were conducted with three mamas working at the fish market. The first of the two was about pain points and the second about a future dream scenario. Lastly, the prototype was co-built together with two local contractors.

1. *Cleaning with the community*

For our first workshop, we joined the DECTTA team during their bi-weekly beach-cleanups. This gave us valuable introduction to the Dunga Beach community and helped create a sense of inclusion.



2. *Cooking fish together*

For our second workshop, we cooked fish together with the DECTTA team at one of the local restaurants, using the traditional firewood stoves (jiko). This gave valuable insights into what it means to use a jiko when cooking, and became a good bonding experience with the local mentors.

3. *Pain Points*

The third workshop focused on the existing pain points of the mamas' daily work. Initially, a link analysis was carried out to understand the structure and flow of a typical workday. This was done using a map of the fish market. Following this, a discussion was held around the different places marked on the map, where the participants were asked questions regarding, e.g., their favourite and least favourite places. The purpose of this was to gain clearer understanding of their everyday experiences and identify challenges in their working environment.

4. *Dream Scenario*

Immediately following the previous one, the fourth workshop focused on envisioning what their ideal workday could look like. The workshop was inspired by the concept of the "Dream Wall" (Architecture Sans Frontières UK, n.d.), but was adapted and modified to better fit the specific context and the needs of the users. A number of open-ended questions were presented on a large sheet of paper, and the participants were encouraged to write, draw and discuss their thoughts and ideas around a desired future scenario. Materials such as pens, post-its, and a large collaborative workspace was used to enable and support participation and collective reflection.



5. *Building*

Co-building the prototype taught us valuable lessons that could not have been gained through formal interviews alone. By working alongside local craftsmen and spending time in the fish market, we gained deeper insights into everyday practices and challenges. The process also highlighted the importance of flexibility and adaptability, as the Kenyan way of working often differed from the Swedish one. Learning to navigate these differences strengthened our ability to collaborate across cultural contexts.



3 FINDINGS

Much was learned throughout the discovery phase. The stakeholders were mapped out and all of the main energy sources and fuels at Dunga Beach were explored. Furthermore, relevant information about the site of the fish market was gathered, and the needs of the users were discovered.

3.1 STAKEHOLDERS

Fish Mongers

Buying and selling fish is their main task. They buy the fish from the fishermen in the morning and/or afternoon, and then stand in the large building at the market, selling it to customers.

Mamas

The mamas are the women working with preparing fish at the market on Dunga Beach. Customers who have bought fish from the mongers can come here to get them rinsed and cooked.

The Weather

Each day at Dunga Beach is heavily influenced by the weather. The sun makes it possible to dry fish, yet contributes to a hot working environment. The rain fills up the water tank at the market, yet makes the ground muddy and the work more difficult. The weather does not adapt to Dunga Beach, but Dunga Beach must adapt to the weather.

Biogas Plant

Next to the fish market, there is a biogas plant using e.g. fish awfuls for biogas production. A communal stove is available for 200 Kenyan Shillings (KES). The biogas stove is rarely used by the women at the market, however, they still contribute with fish awfuls to the production of biogas.

Firewood Vendors

Most cooking at Dunga Beach uses firewood as fuel. This is sourced from elsewhere, and it is the firewood vendors who buy larger quantities and then sell to mamas, restaurants and households around Dunga.

Customers

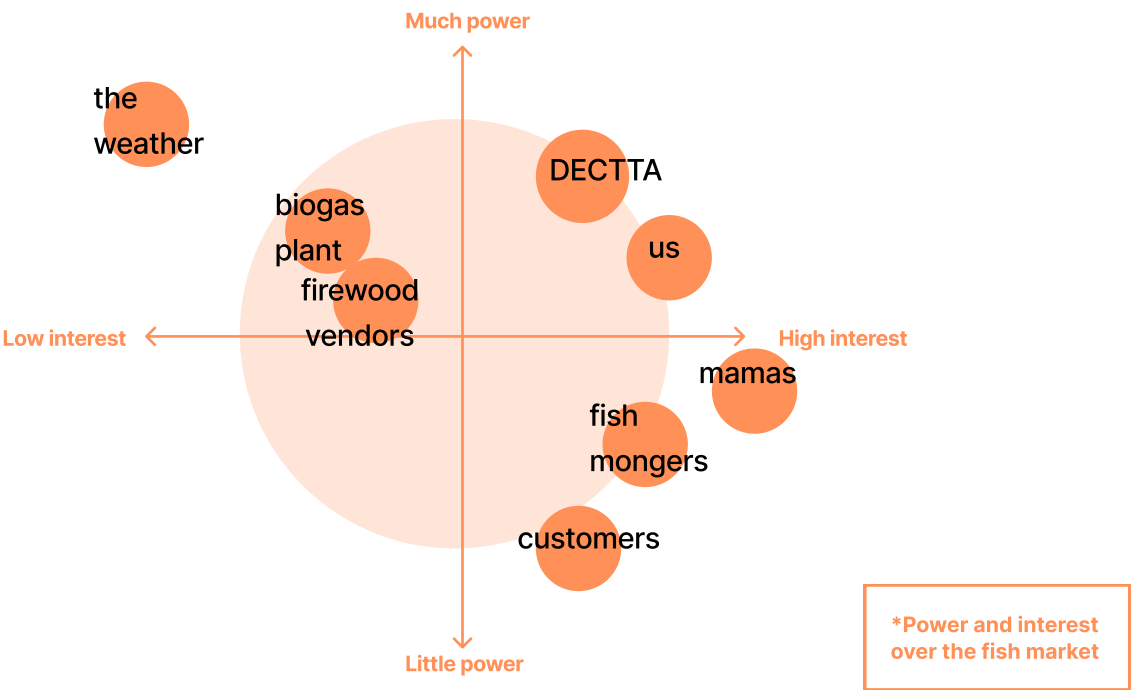
Customers at the market will typically buy raw fish from the fish mongers and then pay the mamas to fry it while they wait.

DECTTA

The acronym “DECTTA” stands for Dunga Ecotourism and Environmental C.B.O. They arrange boat tours around Dunga and educate school classes that visit, and are generally quite influential in the area. DECTTA has also had the role of being local mentors to the project group over the course of the field trip, with around six of their members frequently joining meetings and discussions.

Us (project group)

The project group from Chalmers has worked together with the local mentors and stakeholders to develop an idea and prototype for how to improve the work environment for the mamas at the fish market of Dunga Beach.



3.2 ENERGY AT DUNGA BEACH

Solar Power

The sun is a powerful stakeholder at Dunga Beach and an important source of energy for the local community. At the fish market, sunlight is used to dry fish, helping to preserve it or prepare it for frying.

Several restaurants at Dunga Beach have installed solar panels on their roofs, which provide electricity for lighting and various electrical devices. There is also a small trailer equipped with solar panels, known as the Solar Hub. The Solar Hub uses solar energy to power an ice machine that produces large blocks of ice, which are then sold to local restaurants. In addition, it provides battery charging services for electric motorcycles and allows visitors to charge personal devices for a small fee.

Although the sun provides abundant energy, electricity is currently not used for cooking. Instead, it is mainly used for lighting, refrigeration, and charging devices. As a result, there are significant barriers to the adoption of electric cooking technologies in the area.

Firewood

As previously mentioned, firewood is the primary fuel used for cooking and heating in Kenya. Interviews with firewood vendors revealed that it mainly comes from the blue gum tree (*Eucalyptus globulus*), a locally available resource. Firewood is valued for its affordability and efficiency relative to cost.

However, supply is not always reliable due to environmental and logistical challenges. During the field study, deliveries to a local vendor were delayed for several weeks because heavy rains made transport roads inaccessible. High demand also contributes to deforestation and premature harvesting, which limits forest regeneration. In addition, cooking with firewood produces smoke that poses health risks, particularly respiratory problems for those who are regularly exposed.



Biogas

Biogas is a renewable fuel produced through the anaerobic digestion of organic waste (European Biogas Association, 2025). At Dunga Beach, there is a 100 m³ commercial biogas plant located next to the fish market, that uses mainly shredded water hyacinth and fish waste collected from the market to produce gas.

The plant supports five gas burners, used primarily for cooking cereals such as beans and grams in pressure cookers. Interviews showed mixed attitudes towards biogas for cooking: some respondents considered the heat insufficient for frying fish, while others disagreed. One of the mamas at the market noted that cooking fish requires two biogas burners to match the output of a single firewood stove. With around 30 firewood stoves at the market, the current system would not meet the full demand.

Despite this, plant managers reported that excess gas is sometimes burned to avoid pressure build-up, suggesting a mismatch between production, demand, and access - potentially linked to the cost of using the communal kitchen.

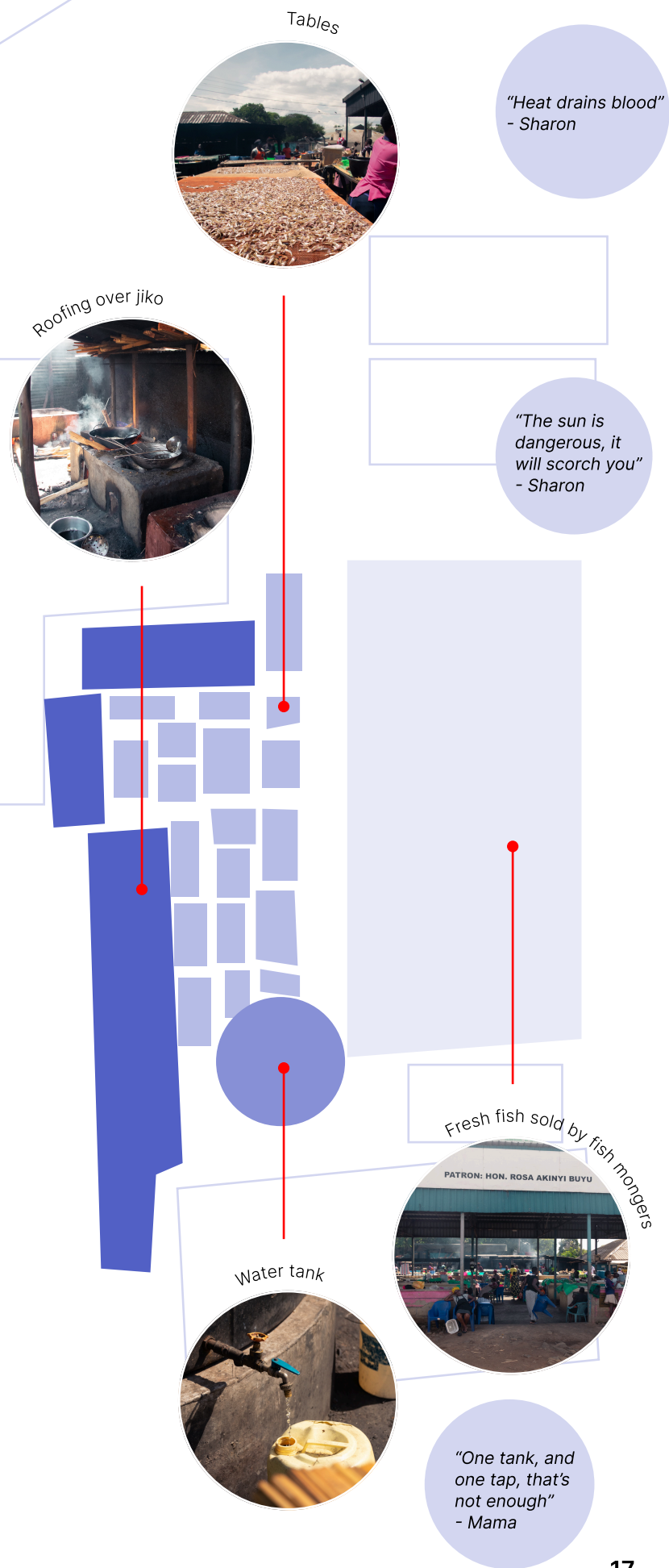
Biogas has clear benefits as a clean and circular system that converts local waste into energy. However, scaling up to serve all the mamas would require additional infrastructure that would be very difficult to fit on the already crowded site, alongside barriers related to cost, attitudes, and cooking performance.

Charcoal

Charcoal is another fuel used at Dunga Beach. It is mainly used for domestic cooking rather than at the fish market. Interviews with a local stove expert revealed that a large proportion of the charcoal is imported from surrounding countries. There were also uncertainties regarding the legality of charcoal production. These factors combined led the project to move away from further exploration of charcoal as an energy source.



3.3 SITE MAP



From Fresh to Fried



3.4 USERS AND NEEDS

The fish market at Dunga Beach is run by women. There's both fish mongers who sell fresh fish and the mamas who fry it. In this project the primary users are the mamas. They are the ones in closest contact with firewood since they use it everyday to fuel the jikos.

The mamas prepare and cook fish that is sold at the fish market. The fish is scaled, gutted, cleaned, cut and then deep fried in oil. After cooking, the fish is wrapped in paper and either sold direct to customers or transported to other places. The mamas work from around 7 in the morning to 7 in the evening with the jiko lit for the most part of the day.

While the existing roofs (made out of corrugated metal sheets) at the market help protect against sun and rain, they also trap heat and smoke from the stoves.

List of needs

Protection from

- Sun
- Rain
- Heat

Customers

- Cleanliness

Water

- For cleaning

For cooking

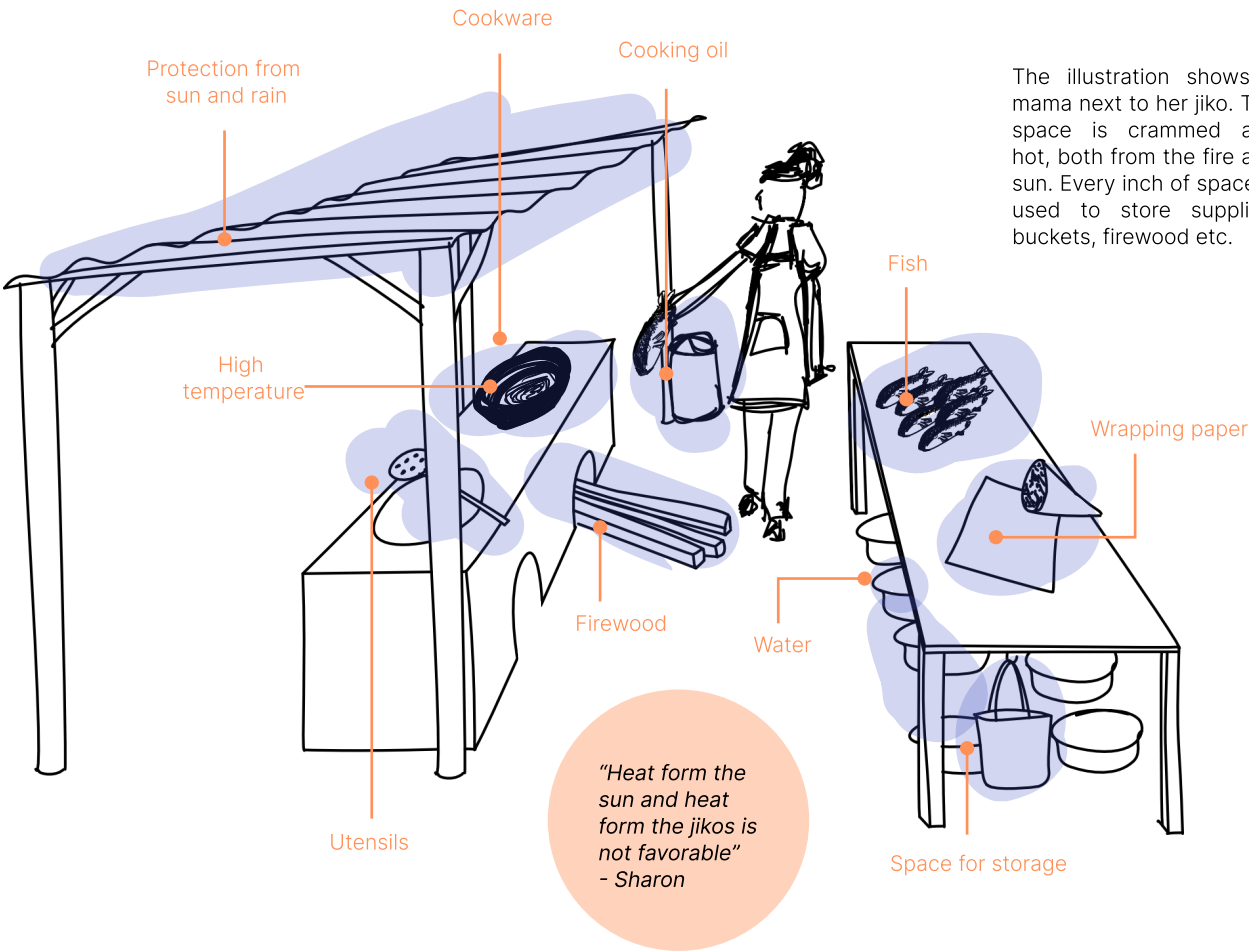
- High heat
- Ingredients
- Cookware
- Supplies

Storage

- Fish
- Firewood
- Personal items
- Wrapping paper
- Cookware

Workspace

- Preparations
- Sundrying
- Frying
- Packaging
- Fresh air
- Water drainage



4 DESIGN

The final design of the concept was the result of a thorough ideation process building on a set of design principles.

4.1 DESIGN PRINCIPLES

From the findings some general design principles were defined which guided the ideation.

Design solutions should meet the most urgent and adressable needs. These include: protection against sun, rain and heat, leading away smoke and providing fresh air. Solutions must also withstand high temperatures and weather such as wind and heavy rains.

Desired functions were to collect rain water, provide firewood storage and be cleanable from soot.

Design solutions must also be easy to construct with local craftsmanship methods, meaning it should be able to build using simple tools like a handsaw, nails and hammer. Materials should be locally available.

An overall demand for the solution was its scaleability. The solutions should thus be developed in a way that can be replicated on the rest of the fish market - with the local context in mind.



4.2 IDEATION

SKETCHES



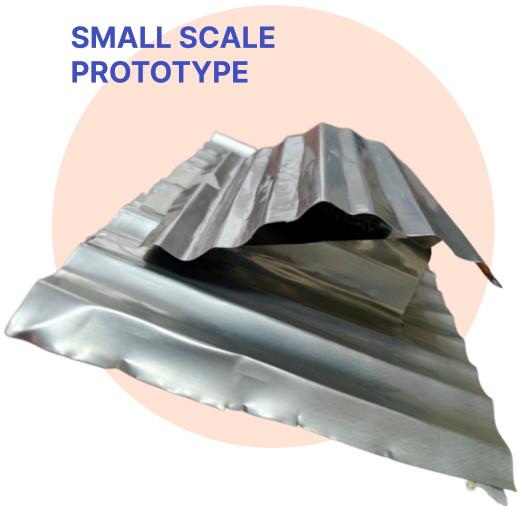
QUICK N' DIRTY MODELS



SMOKE & RAIN TESTING



SMALL SCALE PROTOTYPE

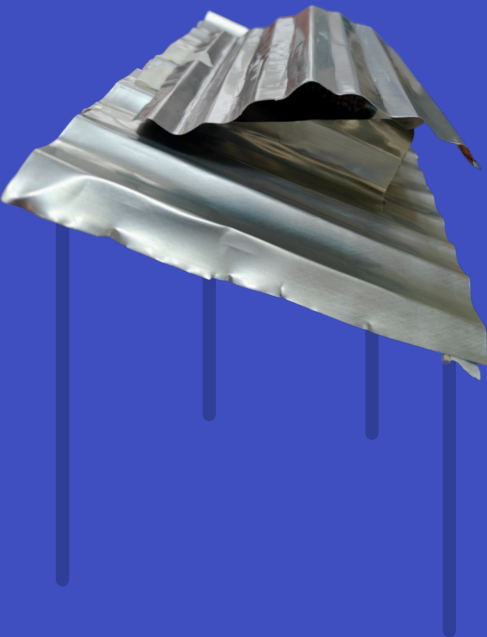


4.3 DESIGN PROPOSAL

The ideation resulted in a design proposal focused on making further implementation accessible. It works by modifying the already existing roof. It is cut open, folded and covered with a metal sheet in a way that still protects from rain and sun while letting out smoke. This way, it uses minimal materials, making it cheaper and lowering the threshold for it to be implemented further.

The small scale prototyping showed that folding the metal, despite being corrugated, would probably work. It is by folding the larger flap instead of cutting and attaching, that the rain is kept from trickling inside. The smaller flaps on the sides help protect against sideways rain, and the top sheet holds the flaps in place while also keeping out rain from above.

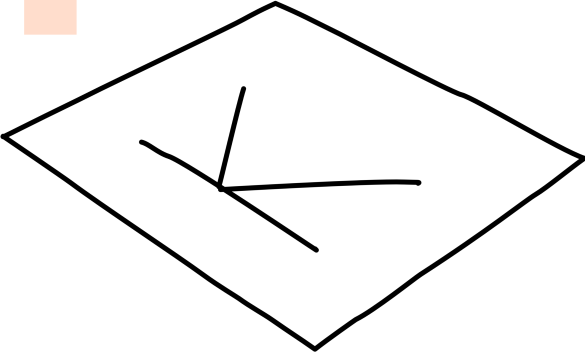
To the left is a step-by-step illustration showing how the concept is meant to be constructed, and below is the physical representation of the concept.



Scale model

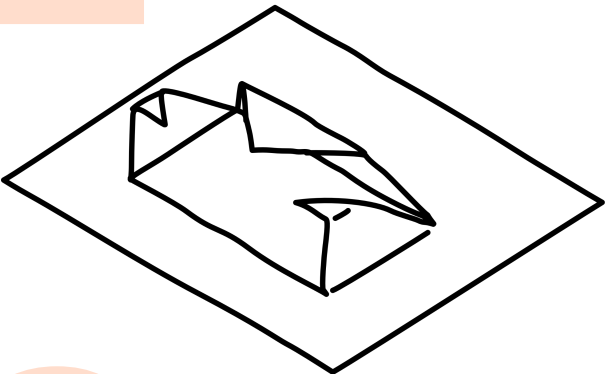
1

CUT A K-SHAPE



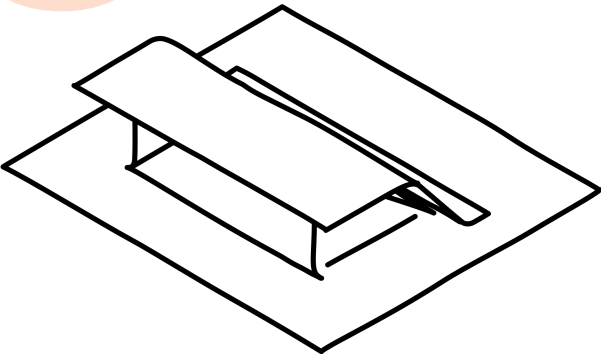
2

FOLD UP THE FLAPS



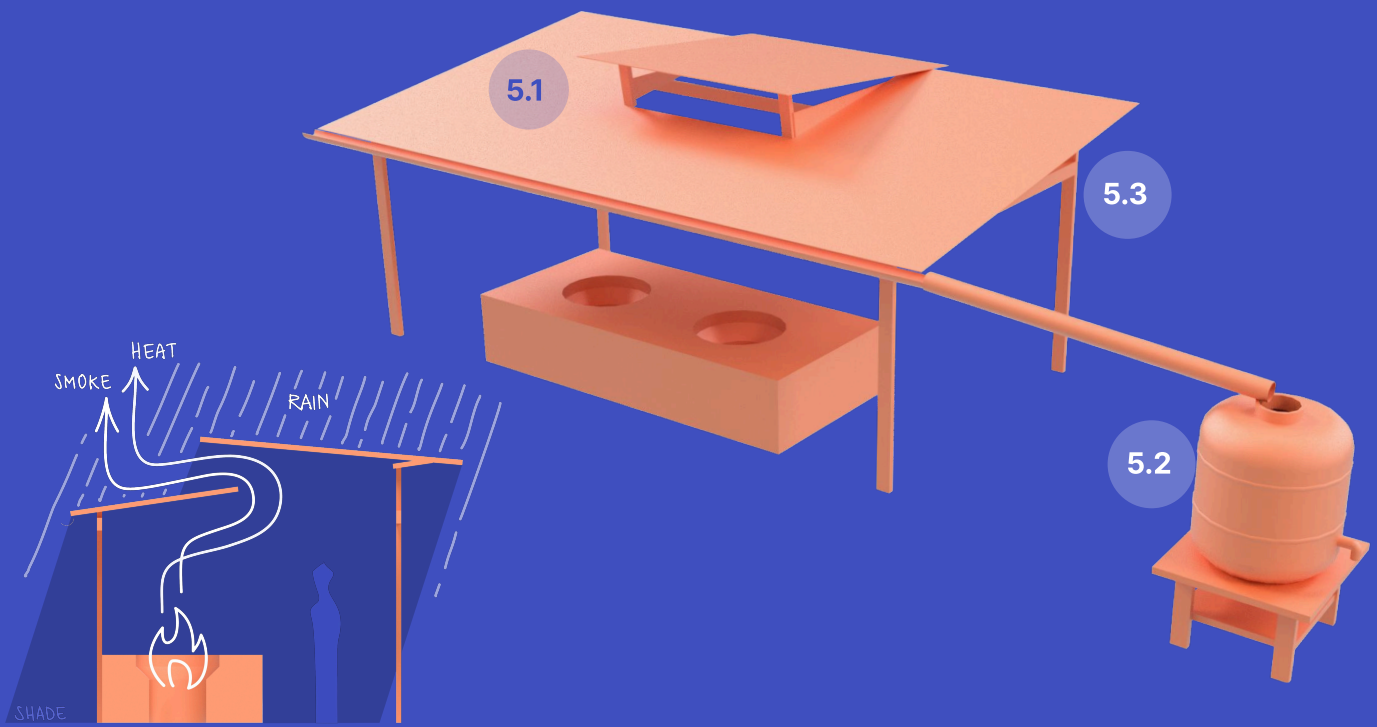
3

COVER WITH METAL SHEET



5 RESULT

The prototype and final result took the shape of a roof with a ventilation hole to decrease the temperature and amount of smoke where the mamas work. To make use of the rain falling on the roof, there is a gutter and pipe connecting it to a tank where the rainwater can be collected and used for cleaning.



Prototype from the side and above, marked in orange outline.



5.1 VENTILATION

Solution

The current solution is built by cutting a hole in the roof and covering it with a metal sheet at an opposing angle, as seen in the photo above. The hole is cut at the front edge to stop water from trickling back and in through the hole.

On the left and right side of the hole, small edges have been added in order to avoid rain from the sides.

The hole lets out smoke and heat that would otherwise get trapped under the roof for a longer time, thus lowering the temperature and making the air a little fresher.

Future

There were some differences between the design proposal and the final prototype. The biggest one is the ventilation hole in the structure. Instead of a solution where flaps are cut out and folded, a hole is cut at the front edge and covered with a metal sheet. The ventilation design of the design proposal would therefore be good to try before implementing this on the rest of the market. This would lower the costs and therefore the threshold for it to be realized.

By using the design of the design proposal, the ventilation hole would also not be constrained to the front edge. This way, the ventilation could be put more directly above the jikos and thereby making the the escape of the smoke and heat more efficient.



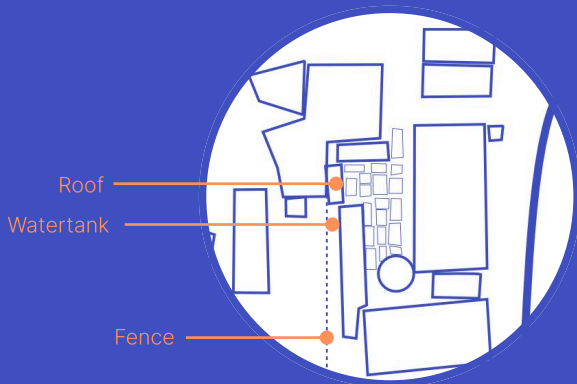
5.2 WATER TANK

Solution

The final solution is a 500 liter watertank that collects rain water from the roof. The tank has a tap, making the water accessible and usable for cleaning.

The tank is mounted on a wooden table with cross supports in the lower frame, providing storage space for firewood.

The tank is placed on the fish market, with the tap toward the fence that separates the market from the biogas plant.



Future

Several future improvements are required to enhance the water tank and its functionality.

Due to the fence, the water is currently difficult to access. A short hose is therefore required for the system to function effectively.

The placement of the tank should be reconsidered. It was originally intended to be located outside the fence near the biogas plant, but the permission was revoked at the last minute. As the fish market is already crowded, the current placement conflicts with the users' need for additional space.

The tank lid should be securely fastened to prevent dirt and contaminants from entering the tank, thereby maintaining clean and fresh water.

For future development, a longer hose capable of distributing water across a larger area of the market would further improve the usability of the solution.

5.3 STORAGE

Solution

There is currently a clear need for additional storage, as the workspace is very crowded. During the construction days, leftover nails were repurposed as hooks, demonstrating the demand for simple storage solutions. Furthermore, the woman who previously used the area where the water tank is currently placed agreed to this only on the condition that she could use the leftover space for storage, further highlighting the need for available storage areas.

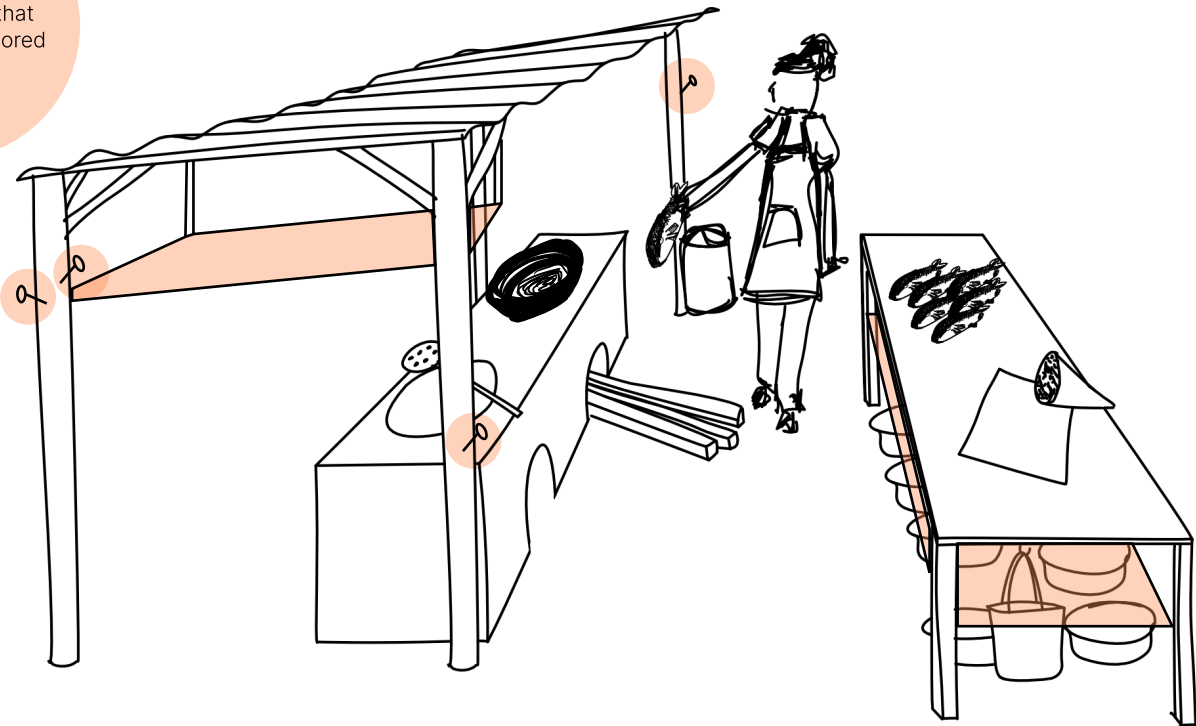
At present, the mamas store buckets, firewood and other items underneath the tables, directly on the ground, behind the jikos or wedged between the walls and the roof structure, or on top of the roofs. This arrangement creates an inefficient and potentially unsafe working environment, as the mamas often reach over open fires to access firewood, utensils or other materials.

Future

Looking ahead, there is a great potential to improve the workspace through the addition of simple storage solutions. Shelves could be installed beneath the roof structure to make use of currently unused vertical space. Additional storage compartments or racks could also be incorporated beneath the tables to organize firewood, buckets, wrapping paper, and other frequently used items. These relatively small interventions could improve organization, accessibility and safety within the workspace.



Potential storage opportunities that should be explored further



5.4 MATERIALS AND COSTS

Costs are in ksh (kenyan shillings):

Labour:	16606
Timber:	13882
Corrugated metal sheets:	11108
Gutters and pipes:	10450
Watertank and tap:	5835
Material transport:	4100
Nails and hoop iron:	3580
Cement, sand and ballast:	2400
Total:	67961

67961 ksh ≈ 4970 sek



Materials were purchased with the help of our contractor. His expertise guided the decisions of which materials to use, where to get them and how much was needed. See appendix D for detailed cost matrix.

The prototype was built from new materials, including the roof, wooden structure, gutter and tank. This decision was influenced by attitudes and experience from local mentors and builders, but also due to the lack of scrap materials.



5.5 EVALUATION

Evaluating with the Users

Evaluating the prototype together with the users, the mamas, provided valuable insights. While the fish market still has significant potential for further development, the evaluation also showed that several aspects of the working environment had already been improved through the implemented changes.

I'm just safe now and I'm so happy! - Jane

Sideways rain comes in; it would be good with a bent roof that protects from the rain - Sharon

It would be great if we had a pipe to get [the water] to here - Caroline

*The air is fresher!
- Caroline*

[The ventilation hole] is taking som heat! - Caroline





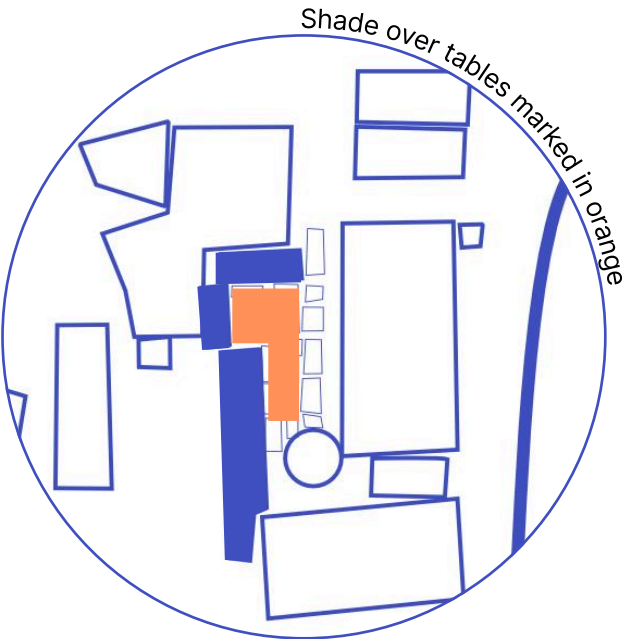
6 MASTERPLAN

What Could Happen Next?

As mentioned in chapter 5, there are several areas where there is room for further development. As mentioned in the evaluation, there is a need for a protecting edge at the roof for protecting from the sideways rain. This is due to the roof being raised which allows rain to fly in from the sideways more than it used to when the roof was lower. This idea comes from the nearby roofing that is over the area where the mongers sell fresh fish, which has a similar solution.

During the evaluation, the mamas also expressed a need for shade over the tables where the fish is prepared before frying. As illustrated by the orange-marked area, covering these tables could improve working conditions by providing protection from the sun. However, some tables, e.g. the ones to the right in the illustration, should remain uncovered, as direct sunlight is essential for drying the fish, which is an important step in the preparation process.

One possible reason why shading has not been implemented previously is that a roof structure could have trapped smoke from the cooking area. However, with the introduction of the new prototype and its ventilation opening, this might not longer be an issue. As a result, adding targeted shading could be a feasible next step in further improving the working environment while still allowing the fish to dry in the sun, and the smoke to be let out.



7 REFLECTIONS

This section reflects on the outcomes and the process of this project. Many of the takeaways concern “soft skills” rather than explicit design skills.

7.1 COMMENTS ON THE RESULT

Intent vs Outcome

As mentioned in section 5.1, the final implemented result differs from the design proposal. The initial intention was to place the ventilation on the existing roof, however, this was not implemented in the final construction. As a result, the proposed ventilation system was never tested in full scale. Whether this was due to miscommunication or because of practical constraints during the building phase is unclear.

The “K”-shaped cut was meant to address water leakage and provide an opening for the ventilation without leading water directly onto the jikos while it rains. How the “K”-shaped cut could be executed and folded upwards is something that could be explored in the future.

The fact that the roofing is higher in the prototype is an important aspect that needs to be taken into consideration. For this to be implemented, it requires investing in new poles which makes the implementation a larger investment than simply cutting holes in the existing roofs.

An additional aspect that was not considered during the design process, but later became apparent, was the reduction of mud as a result of the roofing system. By collecting rainwater in a storage tank and preventing it from reaching the ground, the roofing contributes to a drier and cleaner working environment. The impact of the water collecting would be larger if it were implemented across the entire roofing structure of the fish market.

The Future of Firewood Usage

The future of firewood usage is uncertain and associated with many challenges, as mentioned in section 1.3. These challenges are significant and in the future clean and affordable energy solutions must be explored in line with SDG 7. However, because the mamas cannot afford to miss even a single day of work, this future change is hard to achieve. The implementation of alternative energy sources must be done with high consideration for the mamas and their situation. Because of the benefits that clean energy alternatives would bring - it should be a goal for the future, but it requires a holistic approach and collaboration between multiple stakeholders, something hard to achieve in the scope of this project.

The fundamental problems with firewood are still prominent but the construction of the ventilation in the roofing could offer a more realistic and immediate solution, potentially improving the working environment for the women in their current situation.

All in all, we are very happy and proud of the outcome - the women appreciate it and it has noticeably improved the working environment in regards to the freshness of the air and the heat.

7.2 COMMENTS ON THE PROCESS

Observations

The observations made at the fish market needed time before we were able to fully understand the needs and challenges in the the work environment. Initially, it felt somewhat intimidating to take up space and immerse ourselves in the setting. However, over time we realized that this level of engagement was necessary in order to gain a deeper understanding of the situation and its broader context.

As the field study progressed and the construction of the roof had already begun, we identified additional aspects that could have been considered during the planning process. Becoming more comfortable and familiar within the fish market environment was closely connected to building relationships with the women working there. This proved to be an important aspect of understanding the context more deeply. Our role within the space also changed after the construction of the roof was completed; rather than only observing, we had actively contributed to the environment, which created a different dynamic and a stronger sense of involvement.

Workshops

Planning the workshops with our intended users involved several practical considerations. The women working at the fish market, who were our primary users, had busy schedules throughout the day since their work directly affected their daily income. This required us to carefully consider the timing and structure of the workshops in order to minimize disruption to their work while ensuring meaningful participation. Compensation for their time and effort was also an important aspect to take into account.

Throughout the process, we worked closely with our local mentors from DECTTA. During the planning phase, the mentors suggested that the women might require translators, which led us to include them in the workshop sessions. However, we quickly realized that this level of mediation was not necessary. As the workshop progressed, more members of

DECTTA joined the session, which gradually shifted the group dynamics and influenced the interaction between us and the participants. In hindsight, it would have been valuable to establish clearer expectations regarding the role and involvement of our mentors. Defining in advance when support was needed and when direct interaction with the intended users was preferred could have helped maintain the intended workshop and/or meeting setting.

Building Phase

The building process was both intense and rewarding. At the same time, having control over the process proved challenging, as many decisions regarding the construction were made above our heads both literally and figuratively. In addition, there was a lack of transparency concerning the budget and financial planning. The initial cost estimate



represented only about one-third of the final construction costs, which highlighted challenges related to communication and project management.

When analyzing the material costs, it becomes clear that the gutters account for a large portion of the total expenses, see section 5.4. This suggests that exploring alternative solutions for water collection would be beneficial. Developing a more cost-effective design for rain harvesting may reduce implementation costs and make future installations more accessible and feasible.

Overall Thoughts

When working in someone else's work place it is tricky to navigate who owns what or who is responsible for further developments and reparations. Understanding the ownership of e.g. the roofings is something that would have been beneficial to explore earlier in the process.

Furthermore, defining the limitations earlier in the process could have made these types of explorations easier. At the same time, exploring the broader context was important for understanding the complexity of the situation.



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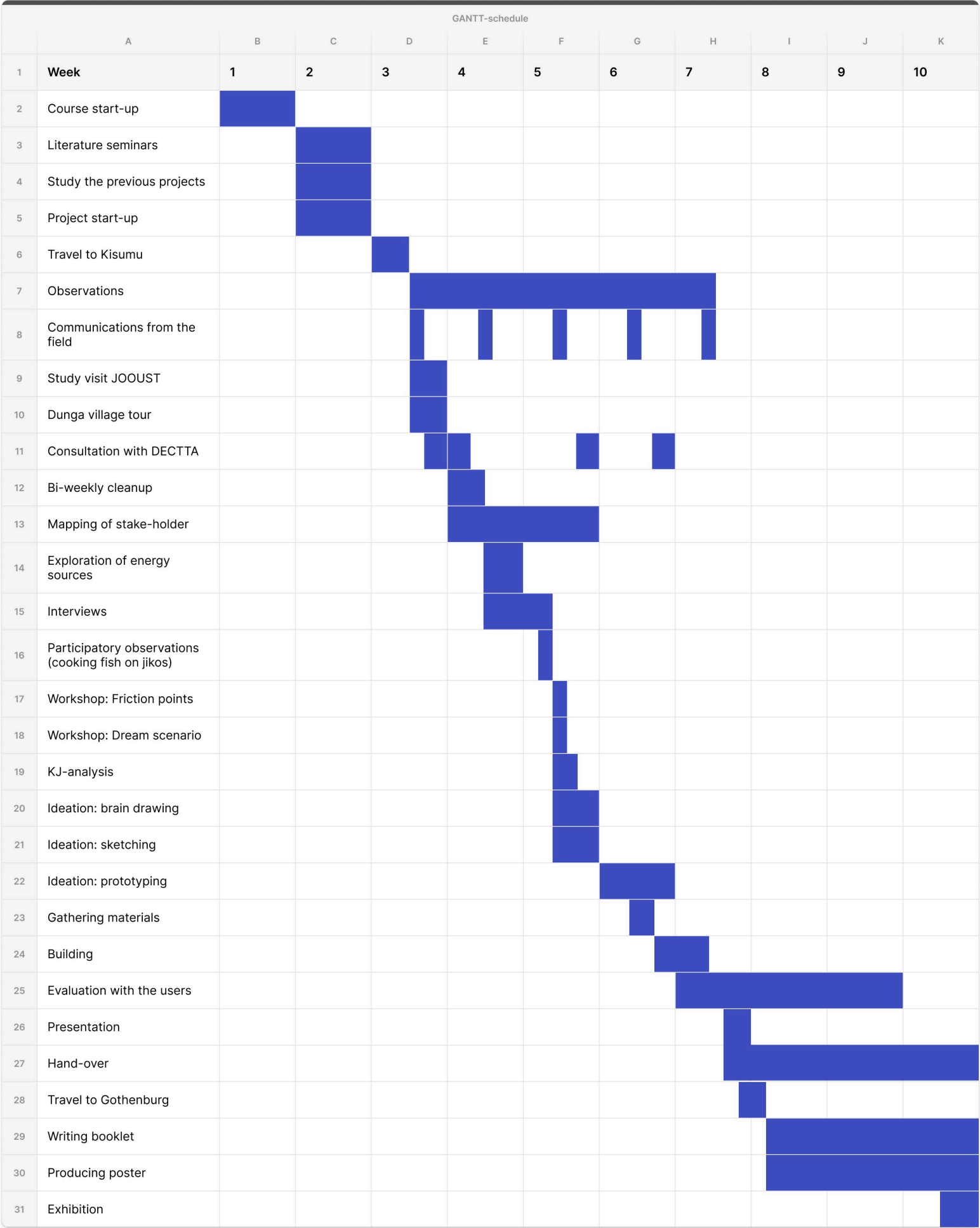
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APPENDICES

A. LOGICAL FRAMEWORK MATRIX

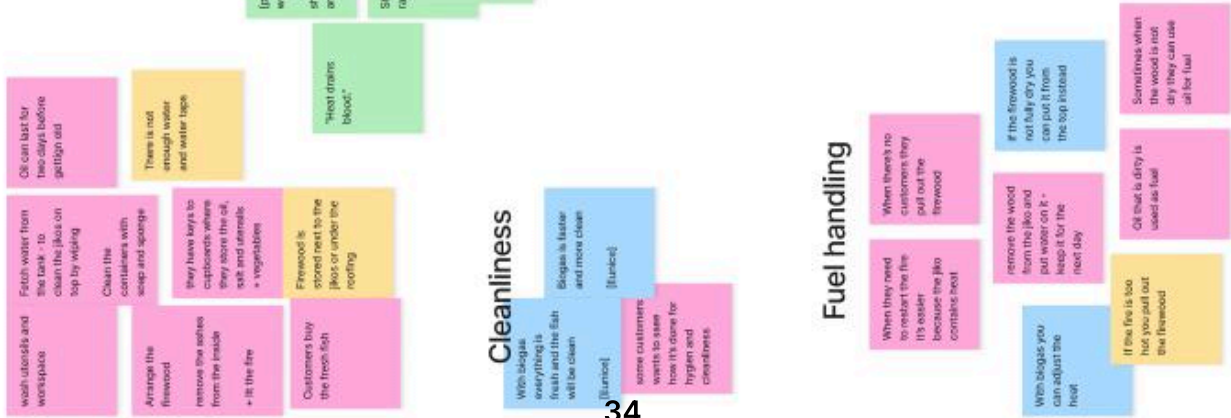
	Project Description	Performance Indicators	Monitoring	Assumptions
Overall Objective	<i>Overall objective:</i> Design for dignity and resilience. SDGs: * 3 (Good health and well-being) * 7 (Affordable and clean energy) * 8 (Decent work and economic growth) <i>Scope:</i> The project focuses on improving working conditions that are related to the use of firewood, for women who fry fish at Dunga fish market.	The project improves dignity of workers in their daily life. Solutions makes the fish market more resilient. Improved health and well-being among workers. Energy use becomes improved for workers. Working conditions are improved.	Follow-up evaluation a year from now, when Reality Studio returns to Dunga fish market.	Our users are not willing/ able to spend money to improve their work environment if it doesn't directly generate income. We assume that the overall goal of the project is to learn and cocreate, to be explorative and not just a one time investment. We assume that Reality Studio will return to Dunga Beach in 2027 to observe how the prototype is doing a year from now.
Project Purpose	The project purpose is to explore possibilities to improve working conditions at the fish market at Dunga Beach. We are focusing on people who work with frying fish. Scope: Energy usage	Working conditions at the end of the project should have been improved: * to have less negative impact on human respiratory systems, * to lower temperatures in the working area * to handle and utilise heavy rain	Perceived freshness of the air Interviews with workers, to see if they are more comfortable in their workplace after project implementation. Observations of smoke and airflow Observations and interviews at the fish market	Lack of time Harder to express latent needs Barrier to getting sensitive feedback and negative opinions from users
Results (Outputs)	A concept A final prototype	A design concept is developed, prototype is tested and final prototype is built.	Documentation of the project process. Photo documentation of the final concept.	We assumed that the prototype could be placed on existing structures to reduce costs and strengthen credibility for further implementation Scrap materials are available
Activities	Observations Interviews Workshop with users and local mentors Ideation Prototyping - building scale models - performing smoke and rain tests Building with local team Evaluating with users	Activities are carried out within the time frame and produce outputs that carry the project forward and strengthens the final concept.	Project plan (ganttt-schedule) Documenting activities Being involved in all activities and all steps of the process (needs findings, ideation, prototyping, purchasing materials, building, evaluating etc.)	Access to participants, materials and builders. To have access to the fish market and to the people who work there We assumed that we would be able to use local materials and scrap materials Transparency and openness between us in the group and local mentors Language barriers Power dynamics influences communication and decision-making

B. GANTT-SCHEDULE

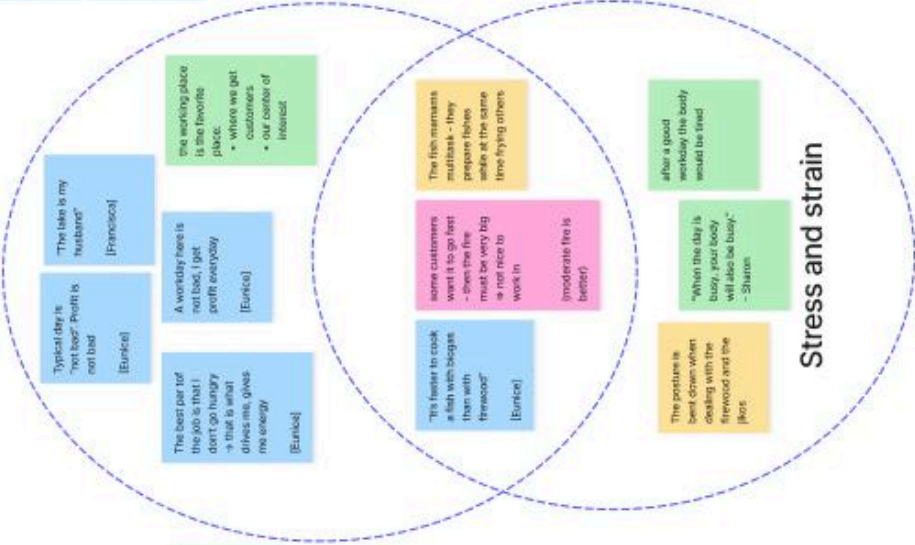


C. KJ-ANALYSIS

Prep and practicalities



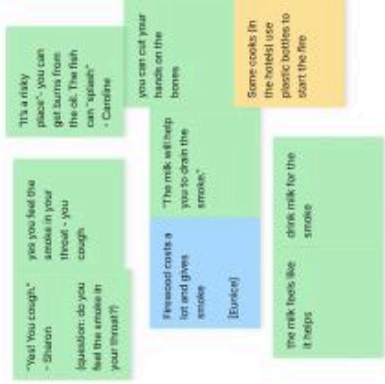
Financial motivations



Biogas barriers



Health and risks



D. DETAILED COST MATRIX

Material	Unit price	Qty	Amount	Subtotal
32gx3m metal sheets	980	9 pcs	8820	
Gutter	1350	2 pcs	2700	
Gutter clips	100	8 pcs	800	
Dr. Fix it Waterproof 1L?	500	1 pc	500	
Cement	900	1 bag	900	
Rubber washers	100	2 pkt	200	
Hoop Iron	200	2 kg	400	14320
Timber 3x2	25	250 ft	6250	
Timber 2x2	22	206 ft	4532	
Timber 6x1	30	20 ft	600	
Nails	180	11 kg	1980	
Roof nails	250	3 kg	750	14112
Sand and ballast			1000	
Gutter connector			300	
Pipe 6"	3200	2 pcs	6400	
Water tank 500L	4500	1 pcs	4500	
Tangit 1/4L	450	1 pcs	450	
GI back nut 3/4"	50	4 pcs	200	
GI long thread nipple 3/4	69,99	1 pcs	69,99	
GI socket 3/4"	45	2 pcs	90	
Thread seal tape 1/2"	25	1 pcs	25	
Gutter outlet	250	1 pcs	250	
32gx2.5m metal sheets	762,5	3 pcs	2287,5	
Roofing nails	250	1 kg	250	14522,49
Tap installation			500	
Timber for watertank construction			2500	
Material transport 30/4			1500	
Transport for gutter connector 1/5			800	
Material transport 4/5			1800	
Labour (fundis)			16606	
			67960,49	4893,15528
		ksh		sek
Sammanfattning				
Metal sheets	11107,5			
Timber	13882			
Gutters and pipes	10450			
Watertank + tap	5834,99			
Nails + hoop iron	3580			
Cement, sand & ballast	2400			
Material transport	4100			
Labour	16606			
	67960,49			

EROKAMANO

