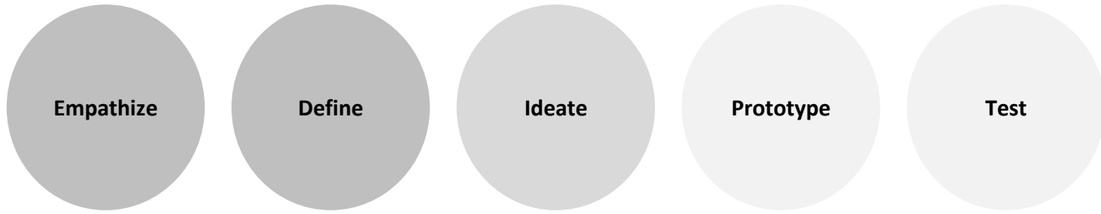
Off-grid Oil Extraction User Research

Off-Grid Oil Extraction: Journey Mapping Users

A journey map is a tool designers use to brings their target users to life. A journey map creates a visual representation of the steps users go through when they interact with a product or service and how they feel at each step. This helps give designers a concrete picture of who their user is and what they really needs.

Here, we combine journey mapping with several other tools to develop representative profiles of off-grid users involved in oil extraction. These profiles are based on interviews conducted in Northern Tanzania and although the stories are fabricated, they are very much based in reality. Using these tools, we create user-focused design criteria that can be used to develop new solutions for oil extraction in off-grid areas.

Design Process



The five step design process developed by Stanford d.school. This research focuses on the first two stages of the design process and briefly explores the third stage.

About This Report

This report is developed as part of an ongoing research project to develop clean energy powered products that can be used productively in agricultural processing.

The purpose of this research is to create a basis of knowledge that frames the problems that off-grid users face when extracting oil. A primary objective is that this information is useful throughout the design process, both for our project but also for others working on addressing the same issues.

This research was conducted by Imara Technology Ltd in collaboration with the Access to Energy Institute (A2EI). The research was supported and funded with UK aid from the British people, as well as with funding from A2EI, 3rd Creek Foundation, the Arthur B. Schultz Foundation, and SK2 Fund. The views expressed do not necessarily reflect the UK government official policies, nor those of any other funder.

Journey 1: Off-Grid Sunflower Farmer

Step 1: Traveling to the Expeller

1.1 Bernard is a farmer that was born and raised in his village, which is in a hilly, sparsely populated area of Tanzania. He lives with his wife and four children at his farm, which is 5 kilometers from the closest market and 50km from the nearest on-grid town. He grows sunflower, maize, and finger miller on his five-acre farm and has one primary harvest season per year. This year, Bernard harvested 840 kilograms of sunflower from his farm. He placed the sunflower into bags that weigh 70 kg each for storage.

One morning, Bernard waits for his young neighbor to come by his house with his motorcycle. Together, they load two bags of sunflower and two buckets onto the back of the bike. Bernard climbs on as well and the rider starts the bike and takes off toward the main road. The road is rough and dusty and the motorcycle comes close to falling several times. It takes them thirty minutes to reach the main road, where they unload the bike. Bernard pays his neighbor 2000 TZS (£0.70) for the lift.

1.2 Bernard stands at the road waiting for the bus to arrive. There is one other person waiting there and Bernard talks to them for a bit before finding a shady spot to stand. He waits thirty minutes for the bus to arrive.

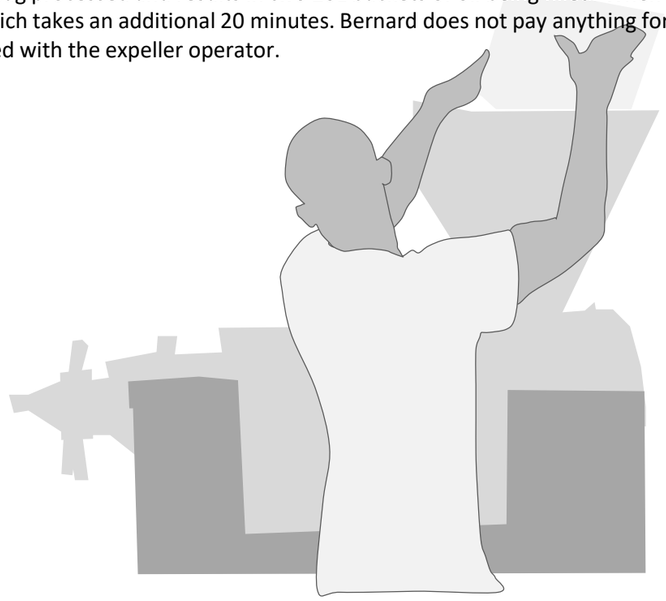
1.3 The bus is crowded but they stop for him and place his sunflower at the top of the bus. Bernard stands in the hot and dusty bus, which is a sea of motion as the bus races down the bumpy dirt road. It takes five hours to reach the main town and Bernard has to pay 15,000 TZS (£5.25) for the ride, which covers the fare for himself and his cargo.

1.4 When Bernard gets off the bus, he flags down another motorcycle taxi. The rider loads Bernard's bags onto his motorcycle but complains as Bernard gets on. The rider drives Bernard 10 minutes to the oil expeller and charges Bernard 5,000 TZS (£1.75) for the ride because of the weight.

Step 2: Extracting Oil

2.1 Bernard greets the guy who owns the expeller business. He is glad to see there is electricity today and that the 20kW oil expeller is working. For the next hour, Bernard hangs around and drinks a soda and talks with others while he waits for his turn to use the expeller.

2.2 Finally, it is Bernard's turn to have his sunflower processed with the expeller. It takes 1 hour and 20 minutes to have each bag processed and results in two 20L buckets of oil being filled. When the oil is ready, Bernard also has it filtered, which takes an additional 20 minutes. Bernard does not pay anything for the services – instead, he leaves his pressed seed with the expeller operator.



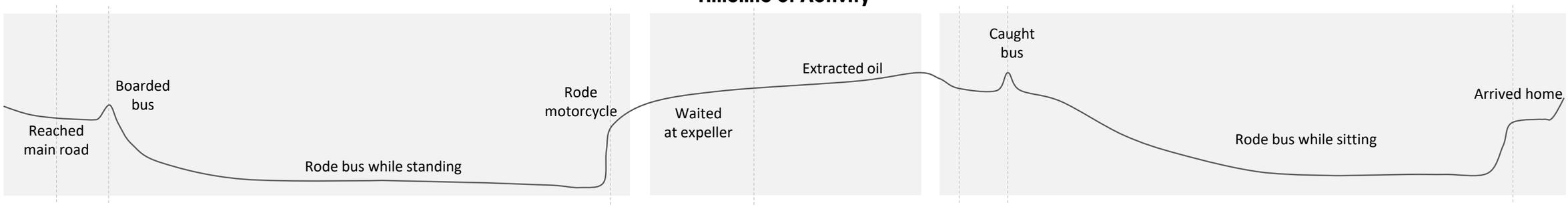
Step 3: Returning Home

3.1 Bernard flags down another motorcycle taxi to take him back to the bus stand. It takes 10 minutes and costs him only 3,000 TZS (£1.05) this time for the ride.

3.2 Bernard waits half an hour at the bus stand before the next bus arrives. He is relieved he didn't miss this one – not many buses go back to his village at this time of day and if he missed this one he might have to stay in town for the night. He loads his sealed buckets of oil in the luggage compartments under the bus and makes sure to position them so that they won't fall over during the journey. It takes another 5 hours to make the trip, but this time he has a set. He only pays 7,000 TZS (£2.45) for the ride because the buckets are small.

3.3 When Bernard reaches his stop it is dark out. He climbs out of the bus and is happy to see that his neighbor with the motorcycle received his text message and is already waiting for him. Together they make the 30 minute ride back to Bernard's farm in the dark. Bernard pays his neighbor another 2,000 TZS (£0.70) to help cover the fuel costs.

Timeline of Activity



Journey Map

	1.1 Travel to Road	1.2 Wait for Bus	1.3 Ride Bus	1.4 Go to Expeller	2.1 Wait at Expeller	2.2 Extract Oil	3.1 Travel to Bus	3.2 Wait for Bus	3.3 Ride Bus	3.4 Return Home
Time	30 minutes	30 minutes	5 hours	10 minutes	1 hour	1 hour 20 minutes	10 minutes	30 minutes	5 hours	30 minutes
Labor	-	-	-	-	-	-	-	-	-	-
Cost	£0.70	-	£5.25	£1.75	-	-	£1.05	-	£2.45	£0.70
Other Pains	Precarious ride	-	Standing in uncomfortable bus	-	-	Left 100kg of spent seed	-	-	Sitting in uncomfortable bus	-
Gains	Reach main road	Ride bus	Reach town	Reach expeller	Rest and socialize	40L of oil	Reach bus stand	Board bus	Reach village	Return home

Assessing Pains and Gains

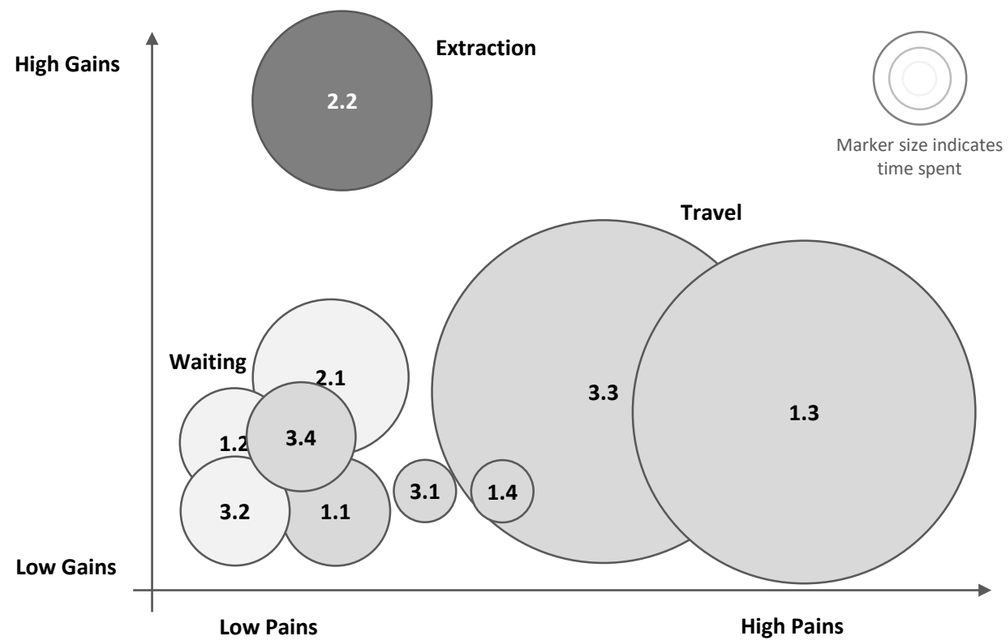
Bernard undergoes a long journey to extract his sunflower, with most of the pains associated with his travel rather than with the process of oil extraction process. Bernard's journey can be categorized into three types of activities: travel, waiting, and extraction.

Travel accounts for the majority of Bernard's time, labor, and expenses during his day. Although his journey is made possible through the use of public transport, he has to adapt his schedule to it and almost fails to make the return trip on the same day.

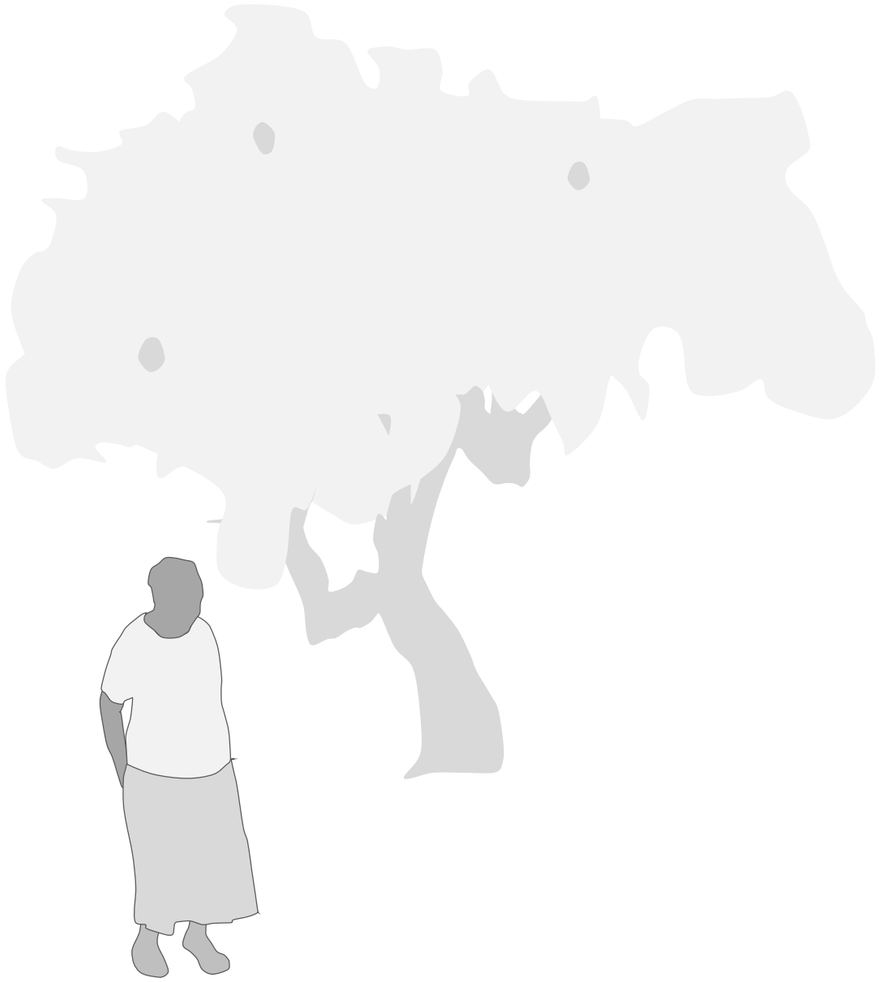
Waiting accounts for the second-most time-consuming activity in Bernard's day. In this journey, he only spends an hour waiting for his turn at the expeller, but it is plausible that Bernard could spend significantly more time waiting. During the peak season, many expellers operate 10-12 hours per day with a steady stream of customers. Delays caused by waiting can compound into further delays when traveling.

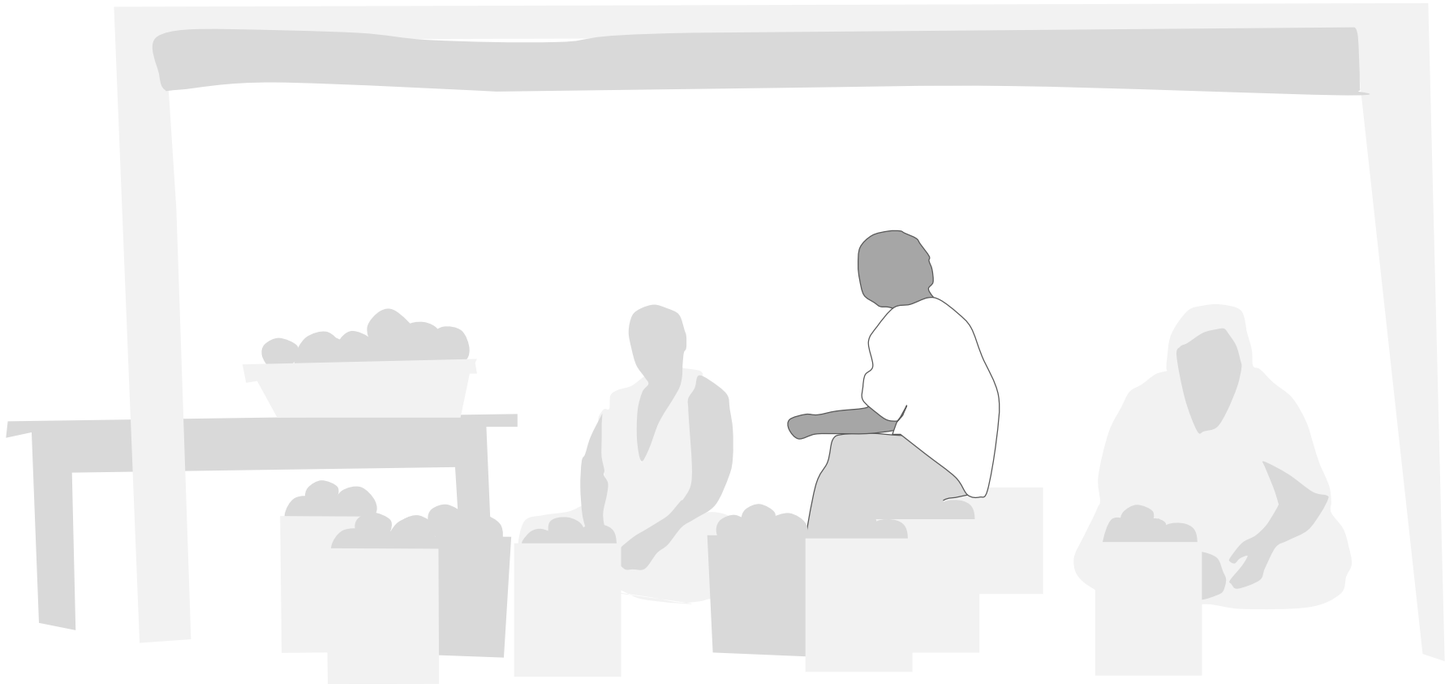
The oil extraction business model in this story is very user-friendly to Bernard. It allows him to make his oil without spending any money on the services. Bernard could have maximized his income by keeping his spent seeds, but for him it is not worth the trouble to find a buyer.

Pains vs. Gains



Journey 2: Avocado Grower





Step 1: Harvesting Avocadoes to Eat

1.1 Pascalia is a farmer in northern Tanzania. She lives with her husband and two children in a house next to their farm, where they grow bananas, maize, and coffee. She has six avocado trees on her farm that shade her coffee trees. The area she lives in is high elevation and lush and cold during the winter months.

When the avocadoes begin to ripen, Pascalia begins to eat them along with some of her meals. She enjoys the avocado, but finds her family doesn't have the appetite to eat more than one avocado each day. Still, it only takes her 5 minutes to pick a ripe avocado and add it to her meal.

Step 2: Selling Avocadoes to Traders

2.1 Pascalia primarily focuses on her coffee and banana crops, but one day someone comes by her farm offering to buy her avocados. She agrees to sell them to the buyer, who proceeds to climb up her tree and shake the avocado from the branches.

The buyer clears two of Pascalia's trees and measures the amount of avocado by placing them in buckets before putting them into bags. Each of the buckets holds approximately 40 avocadoes and each of her trees produces 20 buckets. The buyer pays Pascalia 2,000 TZS (£0.70) for each bucket, a total of 80,000 TZS (£28.00). Pascalia wishes she had earned more from her sale, but is glad it only took 10 minutes out of her day to do the trade.

Step 3: Selling at the Local Market

3.1 One day Pascalia takes some of her avocado to the market to sell. She walks 2 kilometers to sell them at her local market, but everyone in her area already has their own avocado trees and she doesn't end up selling any.

Step 4: Selling at the Main Market

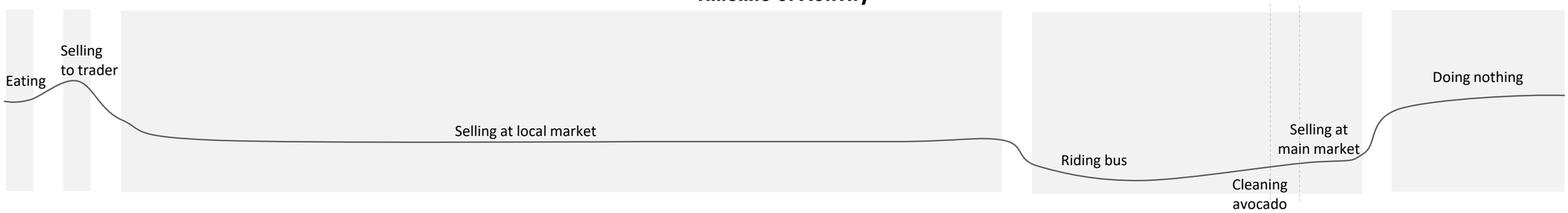
4.1 One day Pascalia needs to head into the city and decides to bring some of her avocadoes to sell at the city's main market. She fills up two buckets with avocado and takes them to the main road where she caches a bus. It takes her 3 hours and costs her 5000 TZS (£1.75) to reach the city. The bus ride is extremely rough due to the bad roads.

4.2 When she gets off the bus, she checks her bucket of avocado. A quarter of the avocadoes have split open due to their thin skin and rough transport conditions. She has to take 10 minutes to wash them off at a water station.

4.3 Pascalia goes to the market and looks for a trader willing to buy her avocado. She asks around to many people but most of the offers are the same: 4,000 TZS (£1.40) per bucket. The traders tell her that there everyone already has avocadoes right now so the price is very low. They also tell her that her avocadoes will go bad in a few days because they are a local variety, so they have to keep the price low. She doesn't like the price but sells them anyway so that she can get to her next business. She receives 6,000 TZS (£2.10) for her sale.

4.4 Avocadoes continue to fall from Pascialia's remaining four trees for the next several months. She still takes them occasionally to eat with meals, but mostly she lets them fall and either rot or get eaten by dogs. She doesn't see much point to having the avocado except to shade her coffee.

Timeline of Activity



Journey Map

	1.1 Eat Avocadoes	2.1 Sell Avocadoes to Trader	3.1 Sell at Local Market	4.1 Take Bus to City	4.2 Clean Produce	4.3 Sell at Main Market	4.4 Do Nothing
Time	5 minutes	10 minutes	Full day	3 hours	10 minutes	30 minutes	-
Labor	-	-	Walk 4km	-	Wash avocadoes	-	-
Cost	-	-	-	£1.75	-	-	-
Other Pains	Utilizes small portion of harvest	Hand over avocado harvest from two trees	-	Broken avocadoes	-	Sell 60 avocadoes	Avocadoes go to waste
Gains	Goes well with meals	£28.00	-	Arrive at main market	Ready-to-sell harvest	£2.10	No time spent

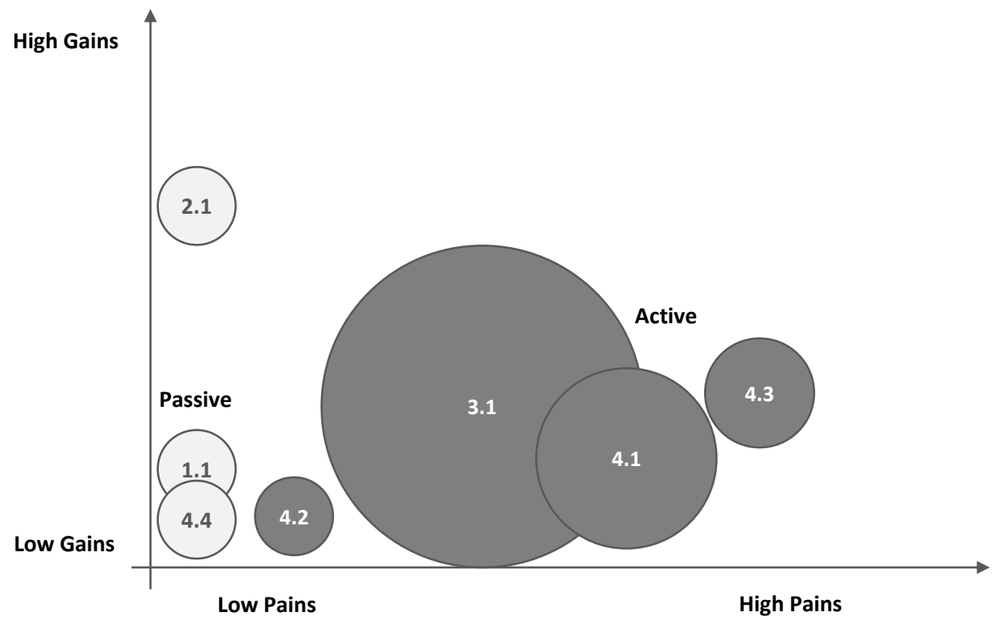
Assessing Pains and Gains

Pascalia's journey spans several months and covers the entire harvest season for her avocadoes. Her journey is characterized by few gains and by the fact that her active efforts to create new gains (such as by going to the market) result in relatively high pains. There are many ways to categorize her journey, but here we break down her activities into two main categories: active and passive.

Pascialia's active activities consist of her trips to the markets to sell her avocadoes. In both, she takes the initiative to sell her crops and create value from them, but finds she earns very little and that it requires a lot of effort due to the perishable qualities of her crop. The trade-off for these activities is so unattractive that it eventually deters her from pursuing them.

Pascalia conducts several passive activities during her journey: eating her avocadoes, selling them to traders who come by, and eventually simply doing nothing. These activities require very little time, effort, or labor from Pascalia, but also produce low amounts of value and are difficult to scale up.

Pains vs. Gains



Journey 3: Expeller Operator

Step 1: Opening the Expeller

1.1 Hendry is a businessman and farmer living in the central part of Tanzania. One of his businesses is his oil extraction business. He bought his 20kW oil expeller 10 years ago as an import from China along with a filtration system. His business is located along the main road that cuts between the Northern and Central regions of Tanzania. The surrounding area is rural, a mixture of rolling hills and plains. Most of the farmers in the region grow maize and sunflower but there is also a mix of grains such as lentils, pigeon peas, and finger millet.

During the peak season, Hendry wakes up at 6AM and after getting ready, he rides his motorcycle 5km from his home to open his business by 7AM. The ride takes 15 minutes.

Step 2: Operating in the Morning

2.1 Two of Hendry's employees are there when he arrives, as are several of his customers who he had seen waiting in line the day before. He starts up his expeller and his assistant helps load the sunflower into the machine. It takes 1 hour and 20 minutes to process all of the first customers sunflower into oil. This customer doesn't have money, so Hendry keeps the spent seeds, which weigh 100 kilograms. His assistants help feed the machines and filter the customer's oil while Hendry supervises.

2.2 The next customer has one bag of sunflower, which takes 40 minutes to process. This customer wants to keep his seeds so he can make his own animal feed and pays Hendry 10,000 TZS (£3.50) for the services.

2.3 The expeller runs continuously for the next two hours. His customers either come with bags of sunflower or smaller 15kg buckets. These customers prefer to leave their seeds with Hendry, and he claims another 150kg of seed.

Step 3: Performing Maintenance

3.1 After 4 hours of operating, the expeller stops turning and Hendry switches off the machine. This happens regularly – between once or twice a month – so Hendry calls one of the nearby technicians to come by with their welding machine. The shaft on the expeller has broken, and Hendry's team and the technician spend the next two hours taking apart the expeller and welding the shaft back in place. It is a messy process as a sticky oil coats each part of the machine. Hendry pays the technician 50,000 TZS (£17.50) for the job.

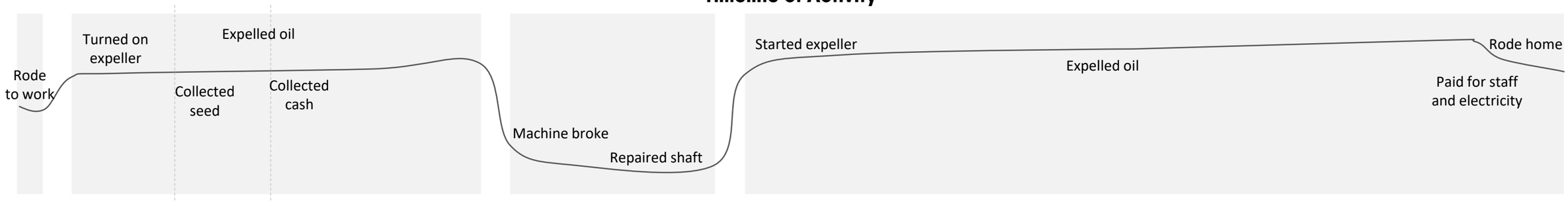
Step 4: Operating Through Day

4.1 Hendry's mill operates continuously for the next 8 hours. The work is not hard, but requires attention to make sure the machines operate smoothly. He trades off with his workers, taking turns feeding the machines or bagging the spent sunflower seeds. After the 8 hours, Hendry has an additional 30,000 TZS and 450kg of seed to add to his haul from the morning. Next week he will take the seed to be processed into animal feed, which sells for 25,000 TZS per 100kg (£8.75).

4.2 At the end of the day, Hendry pays each of his employees 10,000 TZS (£3.50) for the day of work.

4.3 Before closing, Hendry buys 84,000 TZS (£29.40) of electricity to cover his usage for the day. Finally done, he closes the shop and rides his motorcycle back home for dinner and rest.

Timeline of Activity



Journey Map

	1.1 Ride to Work	2.1 Extract Oil for Seed	2.2 Extract Oil for Cash	2.3 Extract Oil	3.1 Repair Expeller	4.1 Extract Oil	4.2 Pay Employees	4.3 Buy Electricity	4.4 Return Home
Time	15 minutes	1 hour 20 minutes	40 minutes	2 hours	2 hours	8 hours	-	-	15 minutes
Labor	Ride motorcycle	Feed machines	Feed machines	Feed machines	Disassemble and reassemble machine	Feed machines	-	-	Ride motorcycle
Cost	-	-	-	-	£17.50	-	£7.00	£29.40	-
Other Pains	-	-	-	-	Messiness	-	-	-	-
Gains	Reach job	100kg of seed	£3.50	150kg of seed	Working Machine	£10.50 450kg of seed	Assistance	Source of power	Arrive home

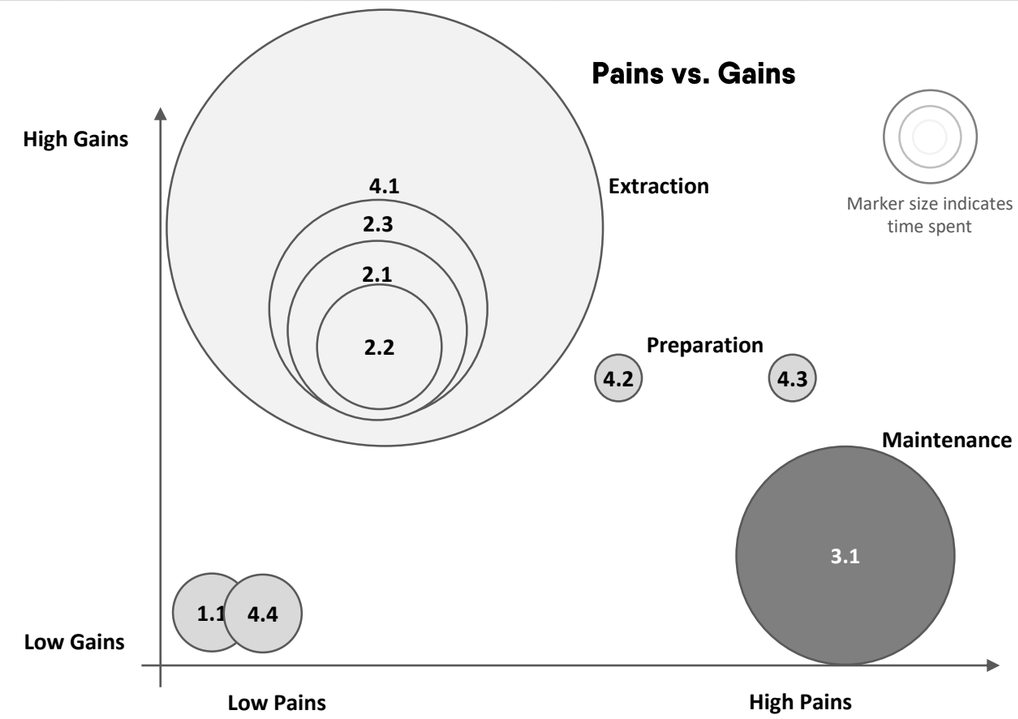
Assessing Pains and Gains

Hendry's journey spans a workday that is full of activity. He pulls long hours managing his business and although it is challenging, he is rewarded for it. Hendry's activities can be broken down into three categories: preparation, maintenance, and extraction.

Hendry's preparations consist of the tasks that are routine and essential but peripheral to the oil extraction process. These include his commute to and from work and the payments that he makes to his employees and for electricity. These activities are not rewarding individually, but enable him to make gains during his extraction.

Conducting maintenance is Hendry's least pleasant part of the day. His maintenance is expensive and has a high opportunity cost associated as well. Depending on what alternatives are nearby, Hendry may lose customers or may just have to extend his work day to make up for the lost time.

Oil extraction is the most lucrative activity that Hendry does. He earns a lot from his business but also has to invest a lot of money into his operating expenses, which are primarily the cost of electricity. Hendry's business model results in him being paid with material rather than money. This implies there are additional steps to his overall journey that are not included here, such as processing or selling the spent oil seeds, but it is expected those tasks are more beneficial for him than being paid in cash.



Synthesizing Design Insights

Identifying Design Considerations

Now that our we have mapped our user journeys, we have an understanding of what challenges and benefits our users experience when extracting oil. By understanding this, we can begin to think about ways to improve the milling process by using the pains and gains that we identified as criteria for success. Any new solution we develop should allow our users to achieve the same result, but with fewer pains and more gains.

Below, our user stories are discussed and aspects of their stories are highlighted. The insights are summarized in the table on the right as a scorecard, which weighs the relative importance of features to the various users.

Scorecard: Important Features

	Bernard	Pascalia	Hendry
Proximity	+++	+	+
Speed	++	+	++
Reliability	++	+	++
Capacity Building	+	+++	+
Efficiency	+	+	++
Profitability			+++

Bernard's Journey: Sunflower Farmer

Bernard's journey is characterized by spending lots of time and money traveling long distances. His journey is also characterized by a sensitivity to timing – if delayed at any part of his journey, it can cost him significantly more time as he relies on scheduled public transport.

In designing for Bernard, the most important feature is proximity. Bernard would benefit the most from not having to take the bus, which is expensive and slow. A closer mill would also make his motorcycle trips easier, as it would become more practical for him to process smaller batches.

Speed and reliability are of secondary importance to Bernard. While no one wants to spend long hours waiting in line or waiting for repairs, the associated time costs are likely lesser than the time saved from transport.

Problem Statement

Off-grid sunflower farmers like Bernard need convenient, nearby oil extraction services in order to press their seeds into oil without spending lots of time and money on transport

Pascalia's Journey: Avocado Grower

Pascalia's journey is a story of someone who has a resource and does not know how to create value from it. Her attempts to add value by selling at markets fall short, and ultimately most of her harvest goes to waste.

Pascalia's most important need is for capacity building. She tries to sell her avocado but cannot find a suitable market due to the variety that she grows. It is possible for her process her avocado into avocado oil, but she needs additional support in order to take advantage of that opportunity. There may be other opportunities to create value from her avocado harvest as well, but she does not know of them.

Other considerations such as proximity, speed, and reliability are potentially important to Pascalia, but a solution that is slow or time-consuming has a good chance of being more beneficial to her than her current best options (doing nothing, waiting for someone to come by, and eating them with her meals).

Problem Statement

Local avocado growers like Pascalia need solutions for what to do with their harvests in order to make full use of their surplus

Hendry's Journey: Mill Operator

As the owner of the oil expeller business, Hendry's journey is about putting every minute of his day to good use.

Ultimately what is most important to Hendry is his business profitability. When considering other features of his business or machine, his preference always leans toward what will earn him the most income.

His profitability is determined by a few key parameters, namely the speed, reliability, and efficiency. Of these, the reliability and the efficiency are important as they are the major cost drivers of his business. Having a high speed machine is also important as it attracts customers and affects how much time he spends at work.

Problem Statement

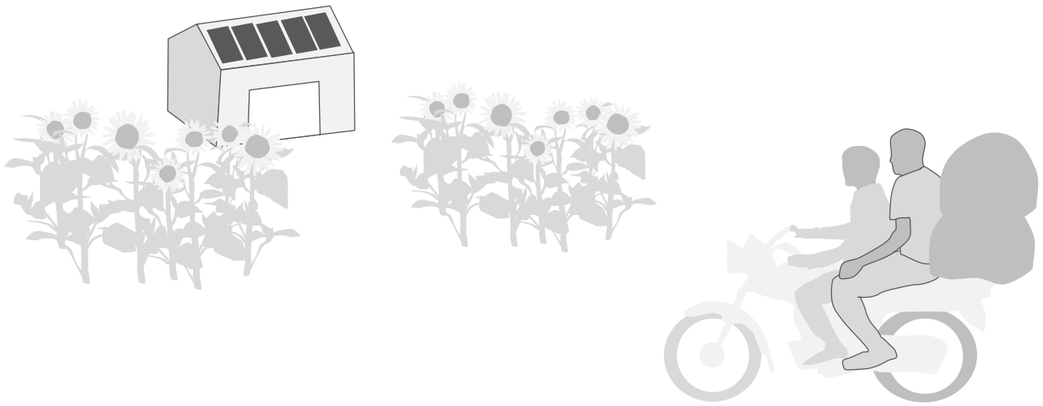
Oil extraction business operators like Hendry need technological improvements related to speed, efficiency, and reliability in order to increase their net income

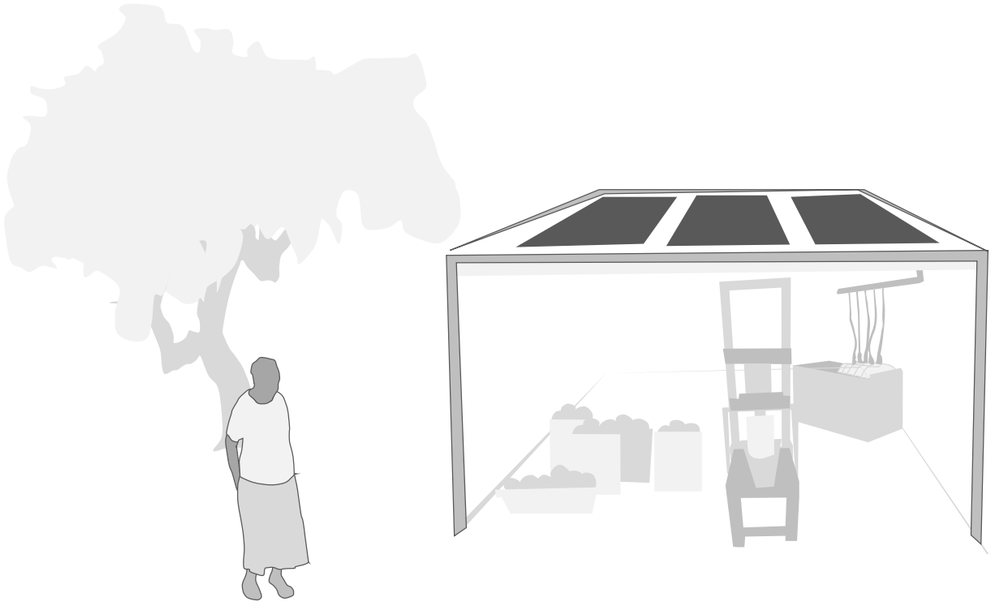
Designing Solutions

Next Steps: Using the Scorecard in the Design Process

Understanding users and the problems they face is the first step to building effective solutions. These user profiles were created as part of a project to develop clean energy solutions to off-grid agro-processing challenges such as oil extraction. The next step of the project is to conduct research and development on extraction technology. After we understand our potential solution space, we can design products that are optimized for our users.

While the R&D is ongoing, for now we give a preview of two generic use cases that we are designing for and what outstanding considerations must be addressed in our design.





Remote Solar Powered Sunflower Oil Expeller

Problem Statement Off-grid sunflower farmers like Bernard need convenient, nearby oil extraction services in order to press their seeds into oil without spending lots of time and money on transport

Target Beneficiary Profile Bernard, Hendry

Overview of Solution A small-scale expeller powered by solar and located in an off-grid area where there are many sunflower farmers

Features
- Proximity: positioned in areas close to users like Bernard, accessible without a bus
- Speed: does not need to be as fast as the on-grid expeller, but should have capacity to serve local market
- Reliability: should be as reliable as an on-grid expeller
- Capacity Building: should be operated similar to on-grid expellers
- Efficiency: Should be more efficiency than on-grid expellers, should be efficient enough that it is profitable
- Profitability: needs to be profitable

Outstanding Questions
- Who will operate the machine? Does it earn enough income to attract someone like Hendry to run it?
- What is the cost? What customer base is required to make the business profitable and on what timeline?
- Who will buy the machine? Can the owner and operator be different people?
- How will extraction speed and customer base affect waiting times and users pains?
- What size customer base does the business need to serve? What proximity is required?

Solar Powered Avocado Oil Press

Problem Statement Local avocado growers like Pascalia need solutions for what to do with their harvests in order to make full use of their surplus

Target Beneficiary Profile Pascalia

Overview of Solution A solar-powered oil press that is implemented as part of a program where local farmer groups are trained on how to add value to avocado and find a market for their products

Features
- Proximity: should be nearby avocado growing communities
- Speed: should be fast enough and have capacity to process avocado from group during season
- Reliability: should be reliable or else able to be repaired easily
- Capacity Building: should be part of a program that organizes farmers and empowers them with technology and business training and assistance
- Efficiency: should be efficient enough to be profitable
- Profitability: should be profitable

Outstanding Questions
- What secondary processes (such as drying) are required to make the extraction work?
- What aspects of the value chain require the most capacity building?
- What stakeholders need to be involved? Who runs and organizes the business?

Annex: Field Photos