

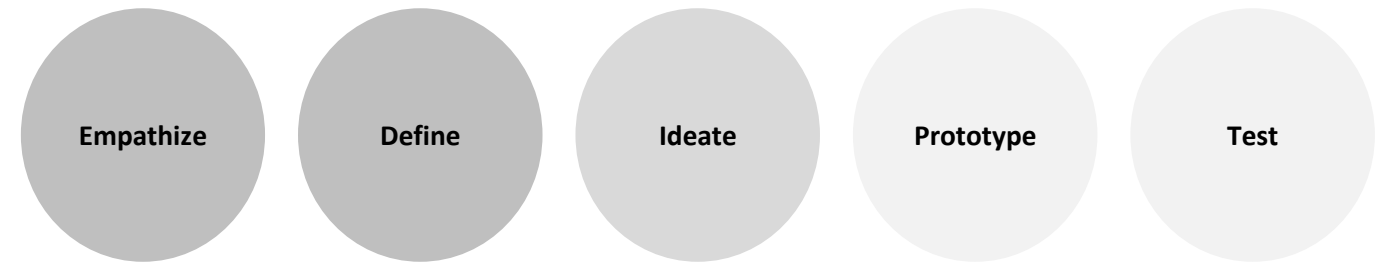
Off-grid Milling User Research

Off-Grid Maize Milling: Journey Mapping Users

A journey map is a tool designers use to bring 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 need.

Here, we combine journey mapping with another visualization tool – story boarding – to develop representative profiles of users involved in off-grid milling. 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 milling 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 users face when milling in off-grid. 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: Small-scale Remote Maize Farmer

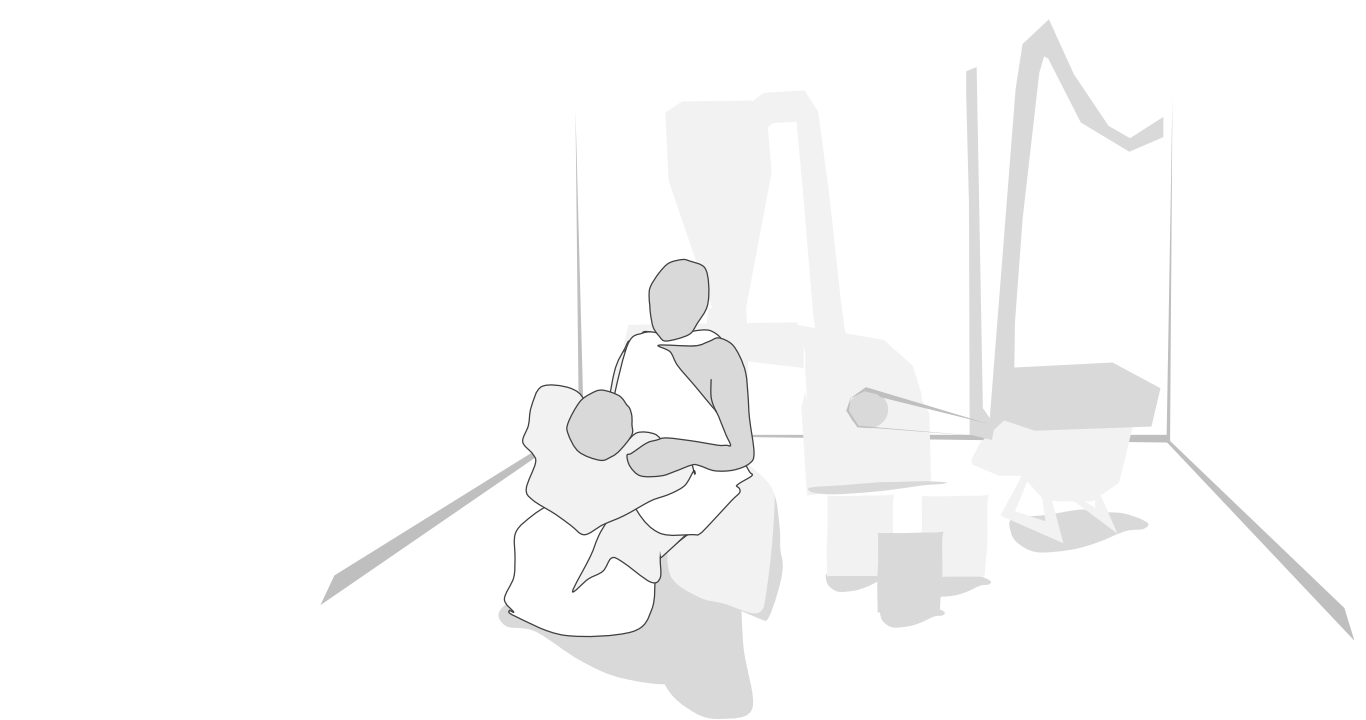


Step 1: Walking to the Mill

1.0 Mary lives in a Masai community in northern Tanzania. She lives on a traditional Masai boma, has one infant child, and manages two acres of land on which she grows maize and beans. The area where she lives is very remote: her house is off-grid and there are only a few other bomas nearby. The closest shops and market area are located 10km away, where a weekly market is held each week on Wednesday.

1.1 Every year after the harvest, Mary stores her maize in large 90 kilogram sacks. She typically harvests 20 sacks of maize and sells 8 of them. The rest she keeps for food. Twice per week on Wednesday and Saturday, Mary wakes up early in the morning, picks up her young child who weighs 9 kilograms, and collects 10 kilograms of maize in a bucket. When she leaves her home, she goes to a meet-up spot to meet with neighboring women to make the trip to the market together. She waits there for 15 minutes before the group leaves together.

1.2 Mary and her neighbors spend three hours walking the 10 kilometers to the market. The trip is hot, dusty, and requires them to cross several gorges and challenging terrain.



Step 2: Waiting at the Mill

2.1 When Mary and her neighbors arrive at the market, they immediately go to the flour mill. The mill is a diesel mill that is housed in a small wooden structure. There are five other women already waiting at the mill. The mill owner is present, but the mill is not turned on.

Mary spends 10 minutes cleaning her maize using the screens at the mill in order to remove any rocks that might be in it. While she does this, the operator leaves without saying anything. Mary knows from experience that he will not turn on the mill until more people arrive.

2.2 Mary waits at the mill with the other women. They take turns watching over their maize while the others go into the market to talk to people and buy small essentials like cooking oil. Several other people arrive during this time and wait with them. After two hours of waiting, the mill operator returns.

2.3 The mill operator starts up the diesel mill. Five other women are in line before Mary and she spends 30 minutes waiting for them to finish. The mill is noisy and the room begins to smell of diesel.

Step 3: Milling Flour

3.1 When it is Mary's turn at the mill, she asks for her maize to be degerminated to make brown maize flour. The operator passes her maize through the degerminating machine before he feeds it into the flour mill. The entire process takes only 6 minutes, and she pays the mill operator 1000 TZS (£0.35) for the services.



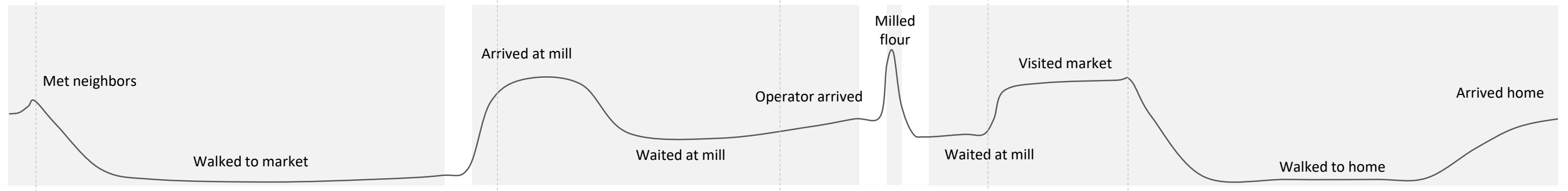
Step 4: Returning Home

4.1 Mary waits another 20 minutes at the mill for her neighbors to finish all of their milling.

4.2 After they all have their flour, they spend another hour walking around the market to purchase goods and socialize with others.

4.3 After they have toured the market, Mary and her neighbors start the return journey home. The trip takes three hours and when she gets back she immediately begins cooking dinner for her family.

Timeline of Activity



Journey Map

	1.1 Meet Neighbors	1.2 Walk to Market	2.1 Clean Maize	2.2 Wait at Mill	2.3 Operator Arrives	3.1 Mill Grain	4.1 Wait at Mill	4.2 Visit Market	4.3 Walk Home
Time	15 minutes	3 hours	10 minutes	2 hours	30 minutes	6 minutes	30 minutes	60 minutes	3 hours
Labor	-	Walk 10km carrying 19kg	Cleaning maize	-	-	-	-	Carry 19kg	Walk 10km carrying 19kg
Cost	-	-	-	-	-	£0.35	-	-	-
Other Pains	Waking up early	-	-	-	Noise, diesel smell	Noise, diesel smell	Noise, diesel smell	-	Arriving home late
Gains	Socializing with neighbors	-	Clean maize	Resting	-	10kg of Maize Flour	-	Socializing with others, buying goods	Returning home-

Assessing Pains and Gains

Mary spends her entire day on her user journey. While her primary motivation is to mill her grain, she makes the most of her trip by finding time to socialize with others and do other tasks. We can break down Mary's journey into four types of activities: walking, waiting, shopping/socializing, and milling.

Walking is the most laborious and time-consuming activity in Mary's journey. She spends 6 hours total walking and makes the journey while carrying her maize and child with her. More than other activities, this is Mary's largest pain.

Mary also spends a large portion of her day just waiting. Some of this waiting is by choice – such as waiting for her neighbors to finish their milling – but a large portion is a result of the ways mills operate. Many diesel mill operators find it most efficient to run the mill at full capacity, which results in either a fixed operating schedule (e.g. only running the mill in the evenings) or an unpredictable schedule that results in users spending a long time waiting.

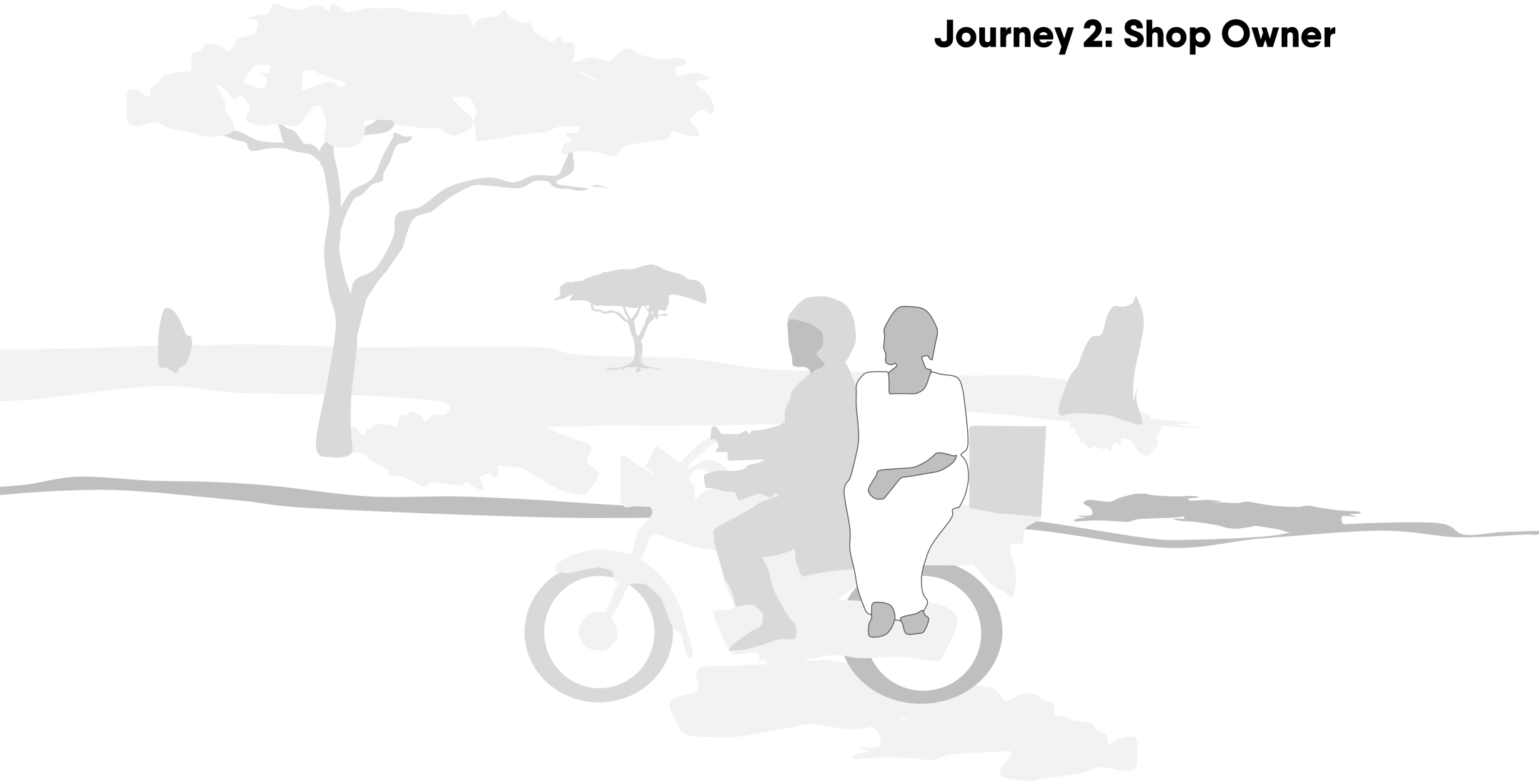
The opportunity to socialize and shop for goods from the market is a secondary benefit for Mary. Were it not for the need to have her flour milled, she would still make the trip to the market, but with less frequency.

Mary's primary reason to make the journey is to go to the mill. Her entire day revolves around having her flour milled, yet it is her briefest activity. Mary's journey is a testament to the difficulty of hand milling flour and the importance of mechanization: she partakes in an amazing and difficult journey because of the value the mill provides to her.

Pains vs. Gains



Journey 2: Shop Owner



Step 1: Going to the Mill

1.1 Neema lives in a rural off-grid area of northern Tanzania. She has two children who are in primary school and a husband who manages their 20-acre farm on which they grow beans and a small amount of maize. Although their farm is more remote, Neema and her family have a home just 2 kilometers from the village center and half a kilometer off the main road. Neema manages a small shop that sells basic household goods and is located in the main market area of the village. She walks to the shop every morning and opens it by 8AM.

Neema and her family vary their meals between rice bought from the market and maize porridge made from their harvest. Every two weeks, Neema restocks her supply of maize flour. She starts by filling a large bucket with 20kg of maize from her stored grain in the morning and then walks 10 minutes to the main road.

1.2 Neema waits at the road for a motorcycle or a bus to pass by. It takes 15 minutes before a motorcycle rider stops to pick her up.

1.3 Neema rides on the back of the motorcycle to one of the mills near her shop at the village center. The road is dusty and rough the whole way but she has made the trip numerous times before and it only takes 10 minutes. She pays the rider 1000 TZS (£0.35) for the ride, her usual fare.

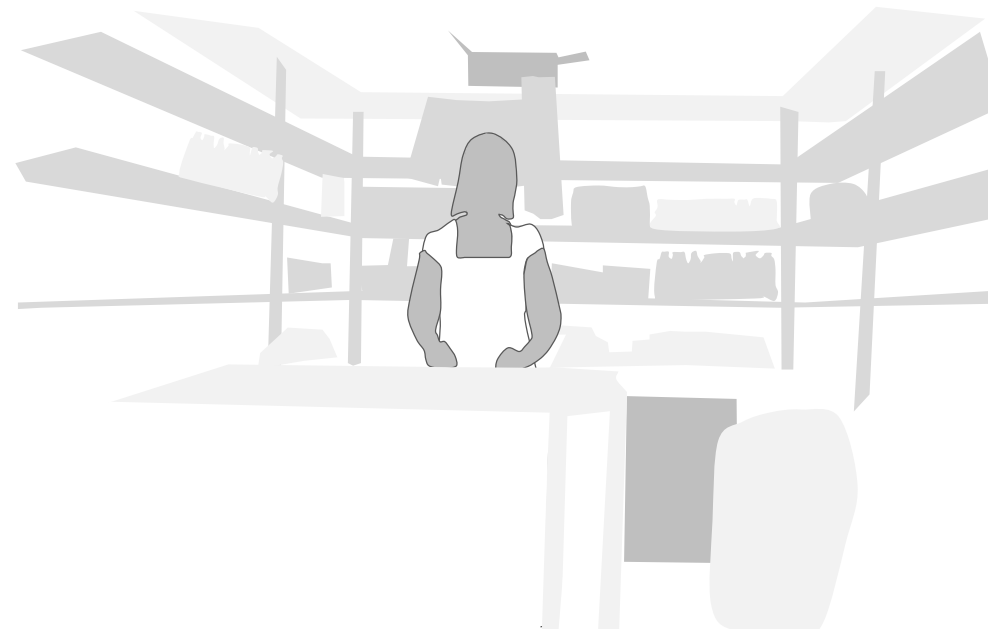
Step 2: Dropping Maize at the Mill

2.1 The mill Neema goes to is housed in a small wooden construct. She has known the owner for many years and knows that he lives just opposite the mill and manages a small workshop. Neema is not surprised to find that no one is at the mill – she knows it never runs the morning.

Neema spends 15 minutes cleaning her maize and then leaves her bucket of maize inside the construct and next to the mill so that it can be milled later in the day. She worries that someone will take some of her maize, whether on purpose or accidentally, but she's not the only one who does it and it's better than coming back later when she would have to close her shop and wait in line.

Step 3: A Normal Day at the Shop

3.1 After going to the mill, Neema has her regular work day. It isn't a market day so not too many people come to the shop. She stays busy by listening to the radio and talking with her customers and her friends who work nearby. After 10 hours at work, she closes up the shop for the day – she needs to get home before it becomes dark and so she can cook dinner for her family



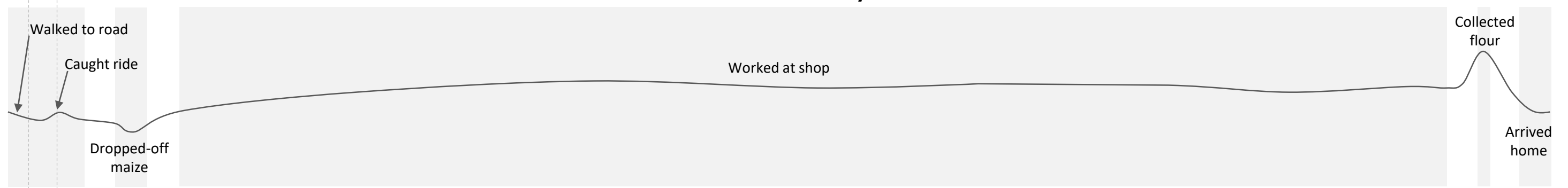
Step 4: Picking up Flour

4.1 Neema goes back to the mill and finds that it is running and there is a line of people waiting outside. Her bucket of flour has already been milled into flour, although the degerminating machine hasn't been working recently. It seems like the flour is all there but she isn't sure. She spends five minutes at the mill to collect her bucket and pays the mill operator 2000 TZS (£0.70) for the services.

Step 5: Returning Home

5.1 There are many motorcycle riders nearby and Neema flags one down to take her home. The ride back takes 15 minutes because the rider takes her all the way to her house. She pays the rider 1500 TZS (£0.52) for taking her.

Timeline of Activity



Journey Map

	1.1 Walk to Road	1.2 Wait for Ride	1.3 Ride to Mill	2.1 Clean Maize	3.1 Normal Work Day	4.1 Collect Milled Grain	5.1 Ride to Home
Time	10 minutes	15 minutes	10 minutes	15 minutes	10 hours	5 minutes	15 minutes
Labor	Walk 0.5km carrying 20kg	-	-	-	Manage shop	-	-
Cost	-	-	£0.35	-	-	£0.70	£0.35
Other Pains	-	-	-	Concerns over loss	-	Concerns over loss	-
Gains	-	-	Arriving at Market	-	Earning income	20kg of Maize Flour	Arriving home

Assessing Pains and Gains

Although Neema's journey is framed around milling grain into flour, it is not the only task she sets out to accomplish. Many of her activities overlap with the journey she makes to work at her shop and come at only a marginal cost.

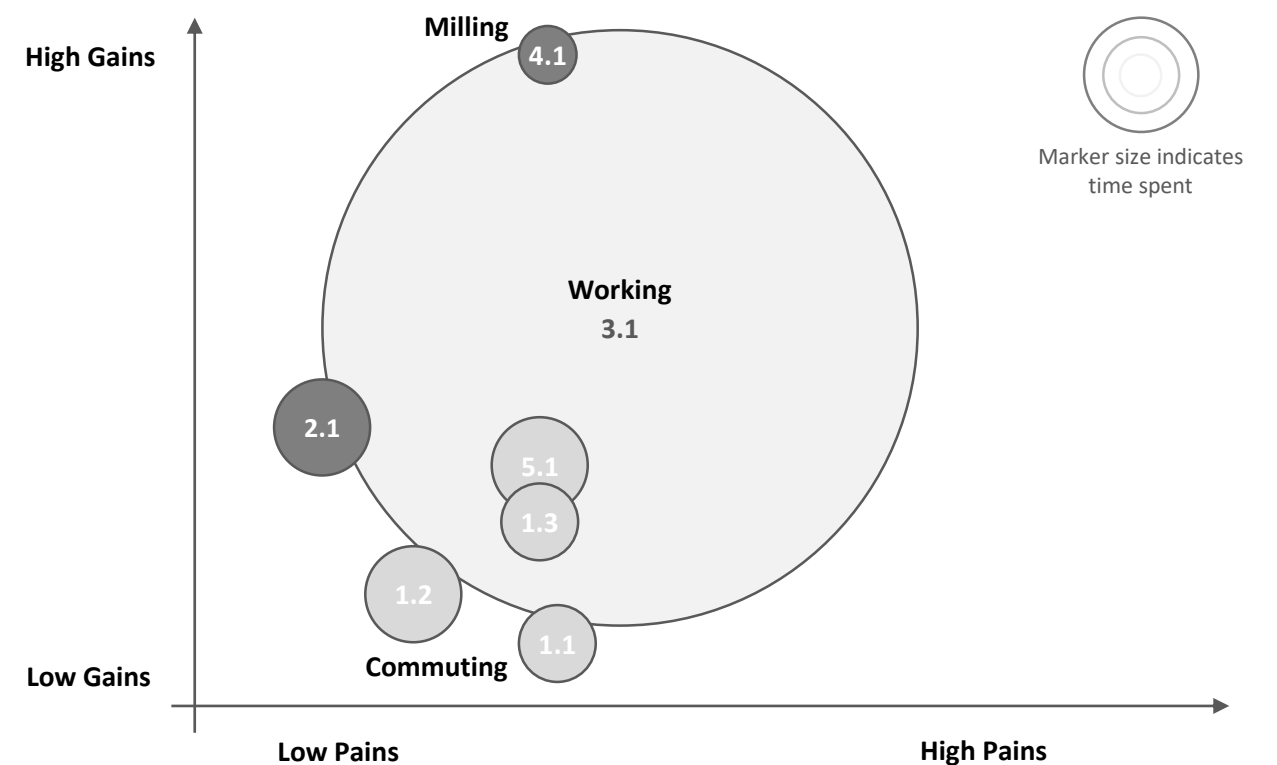
Neema's activities can be categorized into three categories: commuting, working, and milling.

Neema's elects to take motorcycle taxis in her commute because she views the convenience of the ride outweighs the cost: she prefers to spend the money rather than carry the heavy bucket of maize. Because she chooses this option, she does not have to worry about how much weight she carries, which allows her mill a large amount at once and reduce her frequency of milling.

The majority of Neema's day is spent working at her shop. While it is apart of her journey, it exists independently of it. The pains of working and the gains she gets from it are neither enhanced nor diminished as a result of her milling activities.

The time Neema spends at the mill is minimal: she has a busy schedule and cannot spend her day waiting in line or waiting for the mill to turn on. She could avoid this risk by visiting the mill during peak hours in the evening, but that would require her to spend additional time.

Pains vs. Gains



Journey 3: Diesel Mill Operator

Step 1: Opening the Mill

1.1 Frank Julius lives with his wife and three children in a rural area. They have a home 1 kilometer from their village center, but also have a 30-acre farm that is almost 20 kilometers away from his house and is primarily managed by his wife. He bought his first mill ten years ago from the nearest city center – a 5-hour drive away – from a local workshop that also supplied him with a degerminating machine. He also bought two imported 20 horsepower diesel engine from the city to power his machines, but he has had to replace both of those several times since.

Frank Julius is one of three mill operators in the village. Combined, the three mills serve the surrounding region of almost 14,000 people. Frank Julius does not worry about his business competing with the other mills in the area; the mills offer the same services and there are plenty of people who need their grain milled.

On the morning of the weekly market, Frank Julius walks 15 minutes to his mill in the market center. His mill is kept in a concrete building with several windows, which helps reduce the fumes from the generator. He unlocks the door to the building and puts the grain cleaning sieve outside so customers can access it. Now that his mill is opened up, his morning tasks are done.

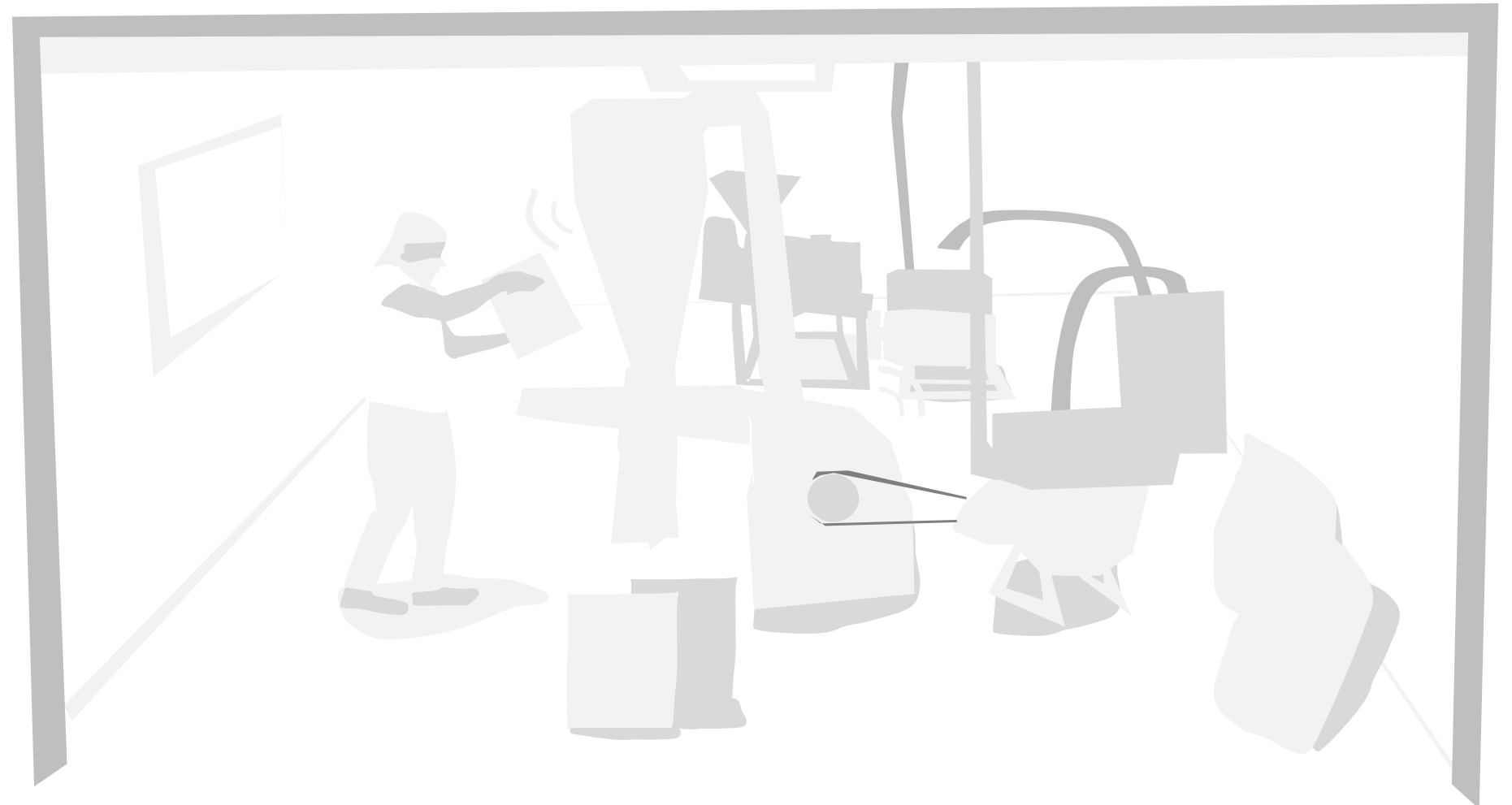
Step 2: Waiting for Customers

2.1 After leaving the mill, Frank Julius goes to his preferred local spot for tea and breakfast. He spends the next several hours speaking with friends, talking with people who traveled in for the market, and watching people play pool at the village bar. He does not bother to check on the mill; nothing there can be easily taken and any customers that have arrived will still be there later.

Step 3: Preparing to Start

3.1 At some point, Frank Julius gets a call on his phone. The technician he uses to work on his mill has received a spare part for the engine. Frank heads back to his mill and meets the technician there. Together, they spend an hour repairing the starter of the engine he uses to power his degerminating machine. He pays the technician 25,000 TZS (£8.77) for the labor and spare part.

3.2 While Frank Julius was out, a number of women came by to his mill. Some of them are waiting there for him, while others left buckets of maize there. He decides there is enough business for him to get started, so he makes a call on his phone while doing the repairs so that someone can deliver 12L of diesel to him from the local shop. It costs him 31,200 TZS (£10.95) for the fuel and delivery.



Step 4: Running the Mill

4.1 Frank Julius fills his engines up with fuel and starts up the engine of his degerminating machine. The engine works now, but it is still hard to start as he has to crank it several times to get it going. Once the engine is running, he begins to feed the buckets of maize into the machine.

4.2 Not long after beginning the work, two of Frank Julius's workers show up at the mill. His helpers know that work usually starts around this time and they hang out close enough that they can notice when the mill begins to work. One of the helpers takes over feeding the maize into the degerminating machine while the other helps Frank Julius get the mill running and begin feeding maize into it.

Over the next three hours, the mill runs continuously and creates a noisy, dusty atmosphere that smells of diesel and maize. Customers continue to come to the mill and it maintains a small but steady crowd of people who stand around outside waiting for their turn. Frank Julius collects the money from each customer, roughly 15 per hour who each pay him 1000 TZS (£0.35) for the services. After three hours, he has collected 45,000 TZS (£15.79) of revenue.

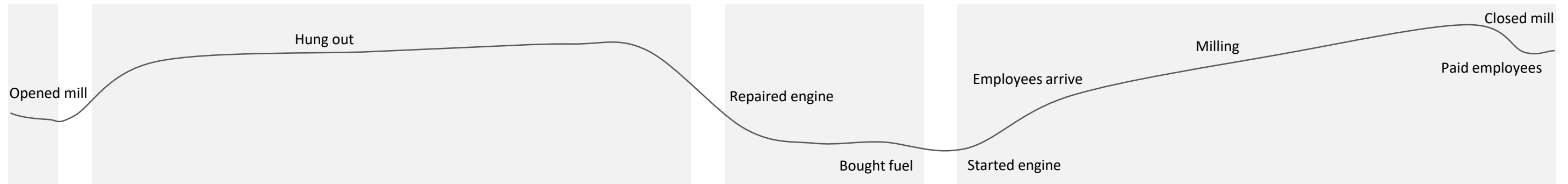
Frank Julius shuts off the mill after the last customer leaves. It was a shorter day than usual due to it being the lean season before the harvest – in the peak season, he can mill twice as much. He and his helpers check the machines for any technical issues that may need more work; there are no pressing issues but he has used all of the fuel that he bought and the mill will probably need a new screen in the next week.

He also collects the bran that was made from the degerminating machine. It is mostly the peel (pericarp) of the maize, and he fills up a large bucket with it. He estimates it to weigh 24kg, and he knows he can sell that for 12000 TZS (£4.20) to someone who makes animal feed.

Finally, Frank Julius pays each of his helpers 3000 TZS (£1.05) for their help for the day and locks up.

After closing his mill, Frank Julius thinks about what he will do next. He might head home or might go back to the bar to see more games played or listen to the radio. Either way, he is done with work for the day.

Timeline of Activity



Journey Map

	1.1 Open the Mill	2.1 Wait for Customers	3.1 Fixing Engine	3.2 Buy fuel	4.1 Start Engine	4.2 Mill Maize
Time	15 minutes	3 hours	1 hour	-	-	3 hours
Labor	Walk 1km	-	Repair engine	-	Crank engine	Feed machines, manage staff, manage customers
Cost	-	-	£8.77	£10.95	-	£2.10
Other Pains	-	-	-	-	-	Use 12L of diesel Fumes, noise, and dust
Gains	-	Socializing, resting	Working engine	12L of diesel	-	£15.79 of revenue Bran worth £4.20

Assessing Pains and Gains

Frank Julius's user journey involves a long period of low activity followed by a period of intense work and labor. He gets a lot of enjoyment out of his morning and although his work is hard, he earns enough to compensate his time and also pay for assistants that do most of the physical work.

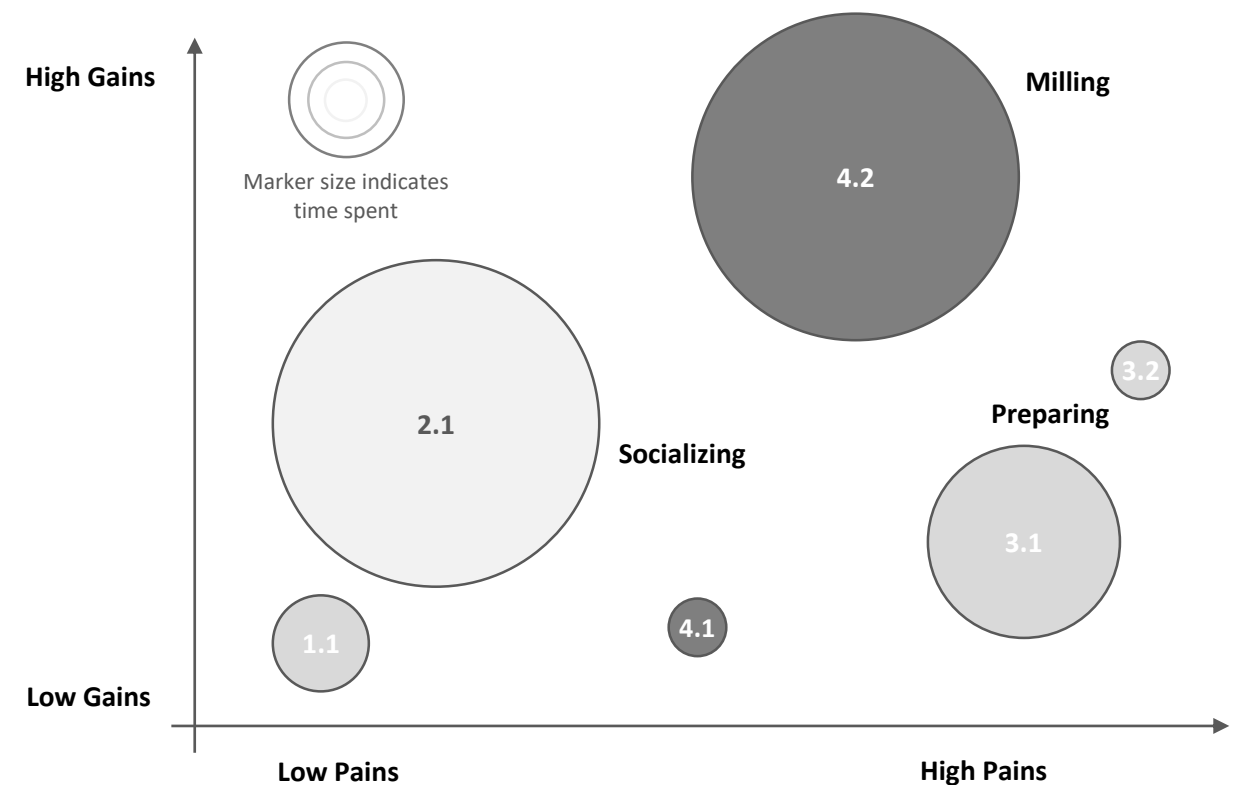
We can categorize Frank Julius's activities into three categories: preparing, socializing, and milling.

Socializing makes up most of Frank Julius's morning. Although it is a sizable part of his day, the demand for his milling services is inelastic and being absent in the morning doesn't hurt his business: the number of customers he has is determined by the surrounding population and season.

Frank Julius spends a fair amount of time preparing for his mill to run. Although it's unlikely that he would have to fix his engine everyday, the diesel engines used in off-grid mills and the mills themselves need regular maintenance and can be expensive to keep operational.

Milling is the most important activity of Frank Julius's day. Although his business provides a decent amount of income, more than half of it goes into operational expenses, mostly toward fuel. As the business owner, a lot of his labor is managerial in nature but it is still a difficult environment for him to work in due to the fumes, noise, and dust created by the mills and engines. On other days, the milling might be interrupted by the need for repairs or maintenance, which is a potentially large source of additional costs and labor.

Pains vs. Gains



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 milling. 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

	Mary	Neema	Frank Julius
Proximity	+++	+	+
Speed	+	++	++
Reliability	+++	+	+++
Operability on Small Amounts	++	+++	+
Opportunities to Socialize	++	+	+
Environment	+	+	++
Profitability			+++

Mary’s Journey: Remote Small-scale Farmer

Mary’s journey is characterized by a difficult and laborious milling process as her primary activity and the main motive force of her day. She also has a secondary activity that consists of socializing and buying goods at the market, which comes at a marginal increase in time and labor.

In designing for Mary, we can see that her greatest pain is the location of the mill. Having a mill closer to her would eliminate a huge amount of time and labor she spends walking. However, this would also cut into her secondary activity and reduce the time she spends socializing and shopping at the market.

Also important to Mary is the reliability of the mill: Mary does not want to walk all day only to find out that the mill isn’t working, either because of technical faults or because the operator has left.

Of lesser importance are the functional operation of the mill: its speed and its ability to work in small amounts. Mary spends a long time waiting for the mill to start and waiting while it serves other customers. While she does not enjoy the waiting and would prefer to not have to wait, it is less taxing than her journey.

Problem Statement

Small-scale farmers like Mary need closer mechanized mills in order to reduce long hours walking to other mills

Neema’s Journey: Shop Owner

It is helpful to frame Neema’s journey as being primarily about working at her shop. Because she goes into the shop every day, the milling activity contributes only a marginal increase in time, labor, and costs to her regular day.

For Neema, the worst part of the milling process is the uncertainty. She leaves her maize at the mill because her schedule is packed with work and she can’t wait around for it to turn on or else come back later and wait in line. This is primarily caused by the diesel engine, which the operators find inefficient to use when run for short periods of time.

The speed of the mill is also important to Neema, but only if she chooses to have her grain milled herself rather than coming back to it later.

Problem Statement

Users who live and work off-grid like Neema need faster and responsive milling services in order to conduct their business without disruption

Frank Julius’s Journey: Mill Operator

As the business owner, Frank Julius’s most important consideration is his mill’s profitability. Above all, his business needs to be profitable.

Also of high importance is the reliability of the mill. Frank Julius’s greatest pain on his user journey is the repair that he does on the diesel engine. The repair is expensive and takes time, but also is expected to be only a short-term relief before the next repair is needed.

Of less importance is the speed of the mill. Due to the inelastic demand for milling, Frank Julius probably does not need a faster mill. However, a slower mill would take his time away from socializing and other activities and would be undesirable.

While non-essential, Frank Julius would also prefer the operating environment of his mill to be less noisy, less dusty, and have fewer diesel fumes.

Problem Statement

Mill operators like Frank Julius need more reliable mills with fewer operating expenses in order to increase income

Ideating 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 maize milling. The next step of the project is to conduct research and development on milling 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.



Small-Scale Remote Solar Mill

Problem Statement Small-scale farmers like Mary need closer mechanized mills in order to reduce long hours walking to other mills

Overview of Solution A small-scale mill powered by solar and located in a remote area

Features

- Proximity: positioned in areas close to users like Mary
- Speed: does not need to be as fast as a diesel mill
- Reliability: should be very reliable – remoteness makes repairs very difficult
- Operability on Small Amounts: should be okay to run even if only one customer is present
- Opportunities to Socialize: would benefit from having other complementary services and goods
- Environment: less important than other factors
- Profitability: needs to be profitable

Outstanding Questions

- Who will operate the machine? Can it attract someone like Frank Julius to run it?
- What is the cost? What customer base is required to make the mill profitable and on what timeline?
- Who will buy the machine? Can the owner and operator be different people?
- How will milling speed and customer base affect waiting times and users pains?

Solar Mill as a Diesel Mill Replacement

Problem Statement Mill operators like Frank Julius need more reliable mills with fewer operating expenses in order to increase income; Users who live and work off-grid like Neema need faster and responsive milling services in order to conduct their business without disruption

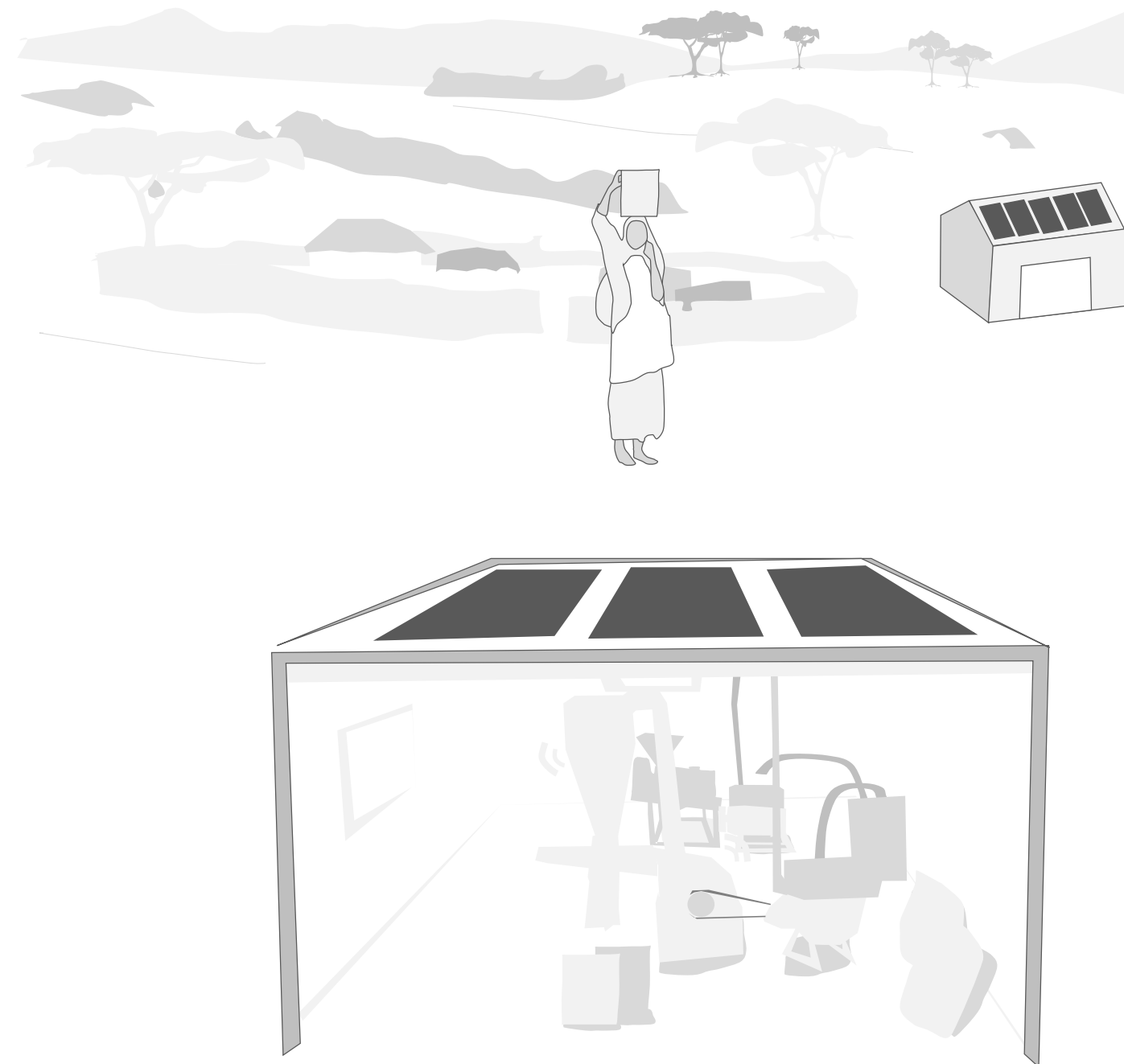
Overview of Solution A solar-powered mill that operates in the same model and locations as existing diesel mills, effectively replacing or displacing diesel mills. Important users to design for are mill operators like Frank Julius and mill customers like Neema.

Features

- Proximity: located in the same areas as diesel mills
- Speed: should be as fast as existing diesel mills
- Reliability: should be as or more reliable than a diesel mill
- Operability on Small Amounts: should be operable with only one customer
- Opportunities to Socialize: not necessary to consider
- Environment: should reduce fumes, ideally will also reduce noise and dust
- Profitability: needs to be more profitable than diesel mills

Outstanding Questions

- What is the cost? What customer base is required to make the mill profitable and on what timeline?
- How will the operator cover the upfront cost of the machine? Can the costs be spread out over time?
- How will weather influence reliability? How much back-up storage is needed?



Annex: Field Photos

