

# Off-grid Peanut Shelling User Research

## Off-Grid Peanut Shelling: 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 peanut shelling. These profiles are based on interviews conducted in Northern and Central 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, 3<sup>rd</sup> 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: Remote Peanut Farmer

## Step 1: First Season: Selling Unshelled Peanuts

1.1 Debora is a farmer in northern Tanzania. She is 55 years old, lives with her husband and their 6 children in a house located in town where there is a national grid and running water. They have a 3 acre farm located 2km from their house where they grow millet, peas, maize and peanuts. 2 acres of their farm is used to grow peanuts, which is their primary source of income and remain stored as food for her family. Debora grows peanuts every year in December and harvests them in March and April. After harvesting, Debora dries her peanuts at her house. After the drying process is complete, her harvest fills 20 sacks that weigh 120kg each.

Since there is no shelling machine in her area, Debora has to either shell her peanuts by hand or sell them unshelled. The middlemen in the area offer to buy her unshelled peanuts at 50,000 TZS (£17.5) per sack. Debora doesn't like to sell her product to the middleman because she thinks their prices are too low, but this season she decides to because she needs the money to help pay for school fees. She spends 16,000 TZS (£5.60) to transport her 16 sacks of dried, unshelled peanuts the 20 minutes to the market.

1.2 At the market, Debora waits 2 hours for the trader to arrive. He purchases all 16 bags for 800,000 TZS (£280.00) and pays her for them in cash.

1.3 Debora chooses to keep the remaining four bags of dried, unshelled peanuts for consumption in the home. She shells the peanuts by hand in the evenings, in the little free time that she has between caring for her family, maintaining her home, and working on the farm. The shelling process is slow and tedious and hurts her fingers, but she tackles it in small pieces. Most days she works through just 1 or 2 kilograms of shelled peanuts, as each kilogram takes 1 hour of work to produce. It takes her four months before she has finally finished shelling all of the harvest that she kept.

## Step 2: Manually Shelling Peanuts with Help

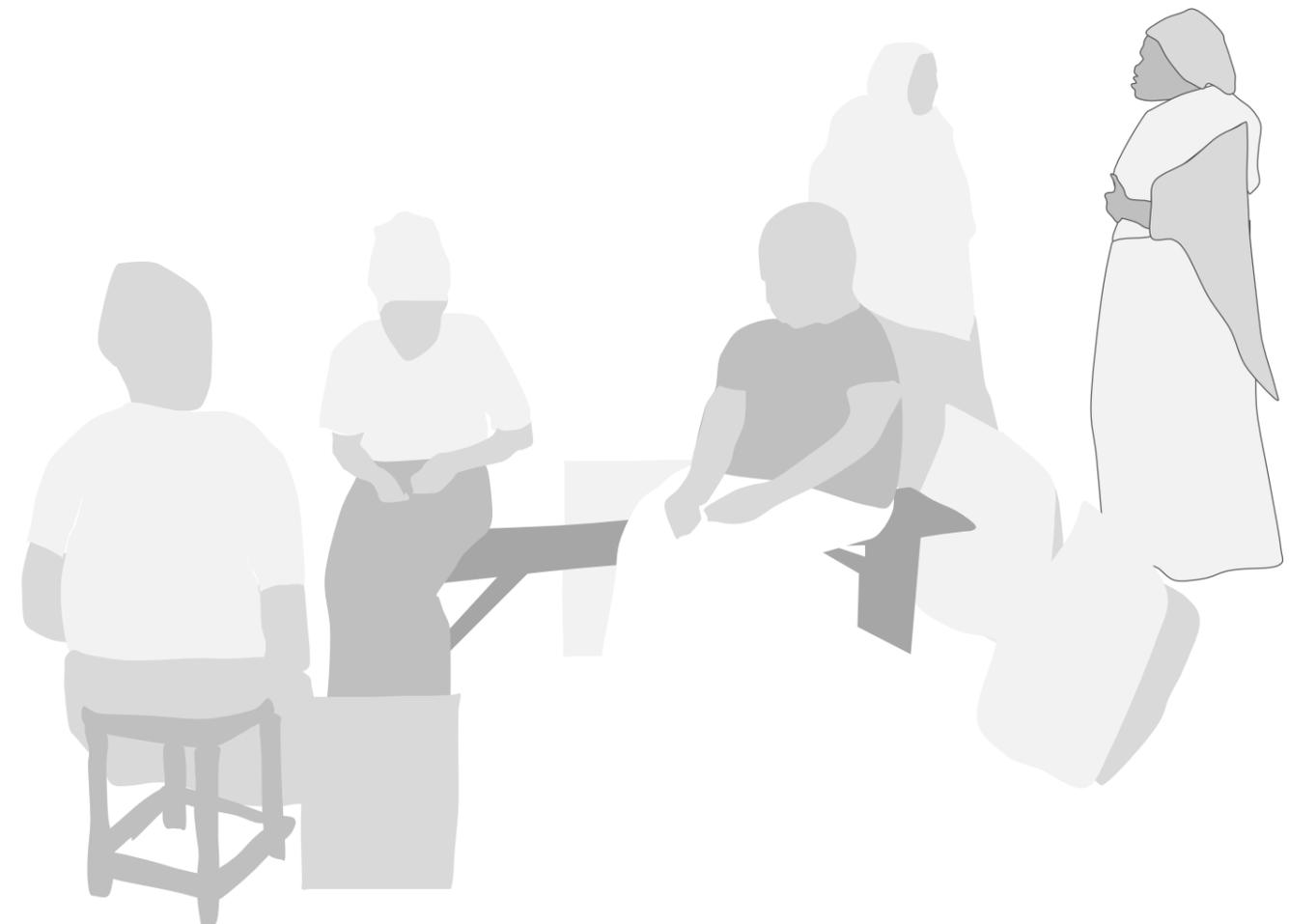
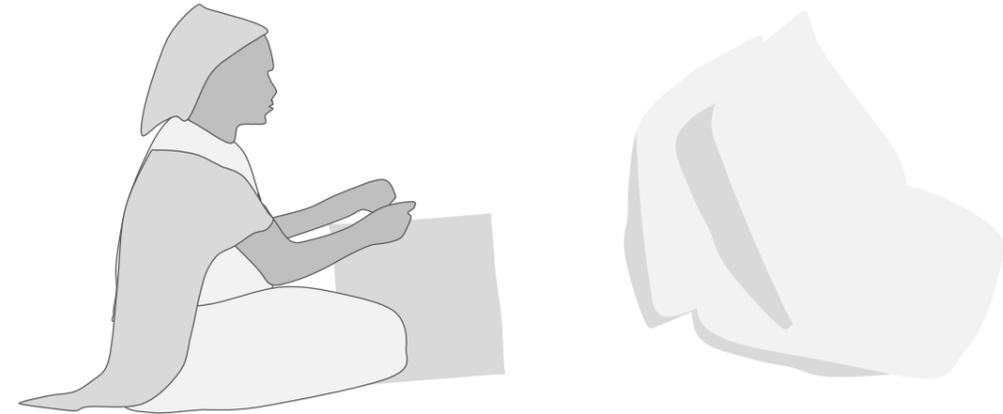
2.1 At the next harvest season, Debora hears about a trader who is looking to purchase shelled peanuts. The trader is willing to buy shelled peanuts at a rate of 2,500 TZS (£0.88) per kilogram. After Debora harvests her regular 20 sacks of dried, unshelled peanuts, she decides to hire some neighbors to assist her with the shelling process so that she can sell the shelled nuts. When the harvest is ready for shelling, Debora hires a group of four women to come to her house and do the shelling for the 16 bags of unshelled peanuts that she wants to sell. It is difficult for Debora to find helpers; most of the community is busy with the harvest and not many people have time to spare. The workers that Debora hires are more reliable than most, but still she has to accept that sometimes the workers won't show up as they deal with their own household and farm work.

Each woman charges 6,000 TZS (£2.10) to process a 120kg bag of unshelled peanuts, which takes 6 days and reduces down to a 40kg bag of shelled peanuts after it has been finished. Overall, the group of women spend four weeks to finish the job, after which Debora pays them a total of 96,000 TZS (£33.60). While they work, Debora and her children trade off monitoring the group. She trusts her neighbors, but it's too easy for a handful to go missing or for the work to slow down..

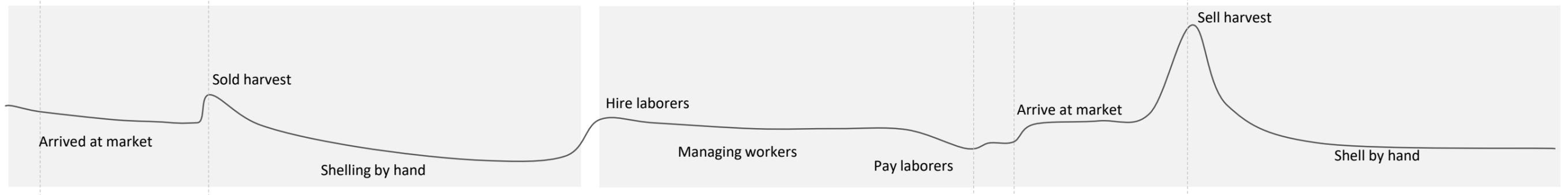
2.2 After all the shelling work is done, Debora places the shelled harvest into bags. From the 16 bags, she now has over 5 bags of shelled peanuts. She calls a transporter to assist her with collecting the peanuts to bring to the city center, where they can be collected and sold. The transporter collects her and the bags and brings her 5km to the main village center, charging her 6,000 TZS (£2.10) for the 20 minute trip.

2.3 Debora spends the morning waiting for the trader to arrive. When he does, they weigh her bags. In total, she has 533kg of peanuts, and the trader buys them for a total of 1,333,000 TZS (£466.67). Debora closes the deal and catches a ride with a neighbor back to her home.

2.4 Like last year, she spends the next four months shelling peanuts in the evening so she can have them for consumption at home.



## Timeline of Activity



## Journey Map

	1.1 Going to Market	1.2 Selling Unshelled Peanuts	1.3 Shelling Peanuts by Hand	2.1 Managing Workers	2.2 Going to the Market	2.3 Selling Shelled Peanuts	2.4 Shelling Peanuts by Hand
<b>Time</b>	20 minutes	2 hours	2 hours per day for 4 months	1 month	20 minutes	2 hours	2 hours per day for 4 months
<b>Labor</b>	-	-	Shelling peanuts by hand	Supervising	-	-	Shelling peanuts by hand
<b>Cost</b>	£5.60	-	-	£33.60	£2.10	-	-
<b>Other Pains</b>	-	16 bags of unshelled peanuts Feels cheated	4 bags of unshelled peanuts	16 bags of unshelled peanuts	-	533kg of shelled peanuts	4 bags of unshelled peanuts
<b>Gains</b>	-	£280.00	160kg of shelled peanuts	533kg Shelled peanuts	-	£466.67	160kg of shelled peanuts

### Assessing Pains and Gains

Debora's story demonstrates the choices that smallholders face when lacking access to mechanization. She balances two goals for her harvest: selling for income and storing for consumption. To accomplish these goals, she undertakes a few critical activities: shelling, managing, selling, and transport.

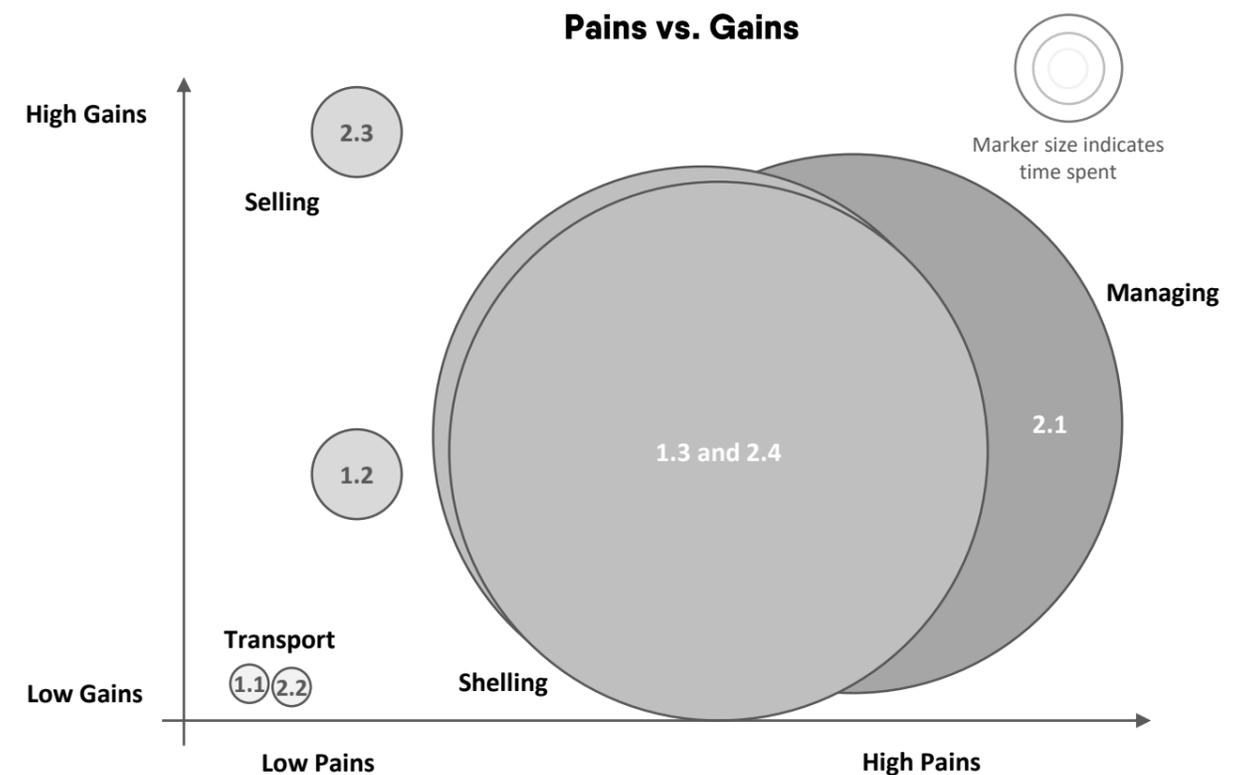
Shelling is the most time-consuming and laborious of Debora's activities. For many months each year, she devotes part of her evenings to shelling peanuts that she intends to consume at her home. In return for this labor, Debora is able to consume her harvest.

Selling is the most financially rewarding activity of Debora's journey, but that does not mean it is without pains. Debora dislikes selling a harvest of unshelled peanuts because she feels she does not earn enough income from it. Still, she sells her unshelled harvest in the first season because she lacks alternatives and needs the money. In her second season, Debora prefers to shell her peanuts before selling, as it nets her almost double the income.

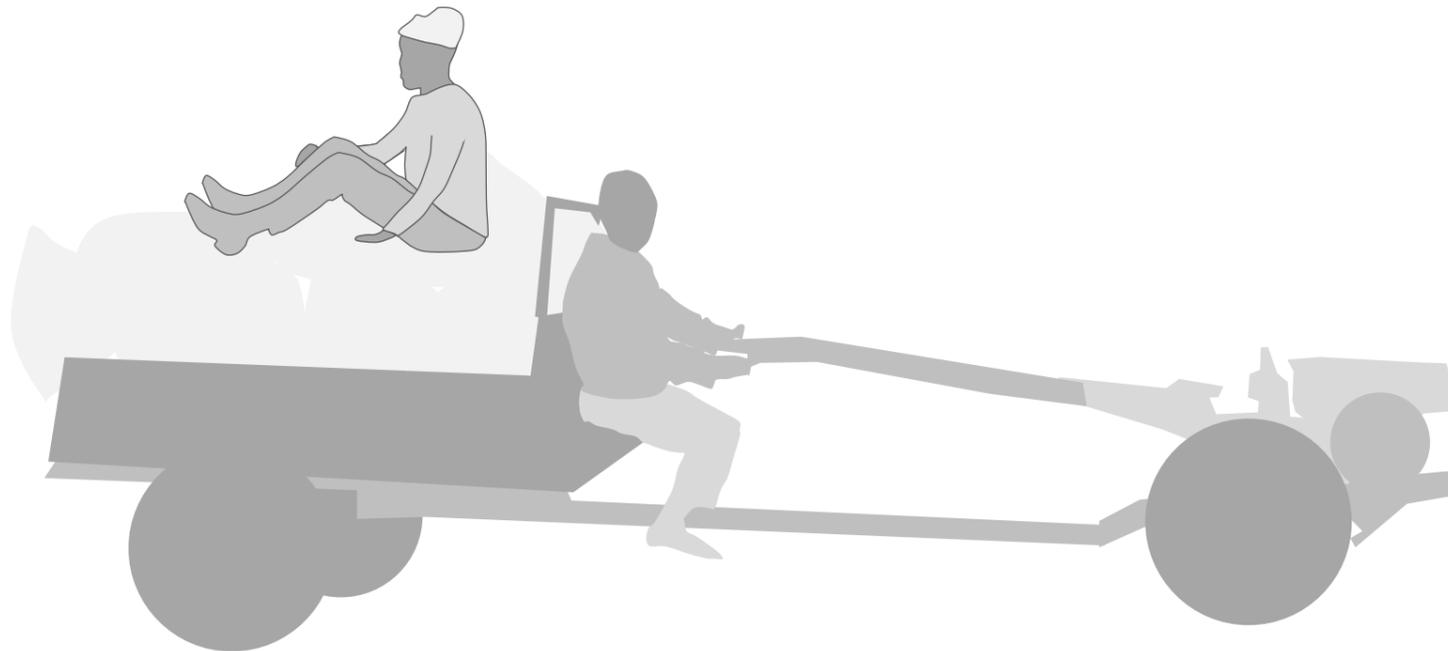
Managing is an additional activity that Debora undertakes her second season in order to fetch higher prices for her harvest. Managing a group of workers is simple enough but consumes a large amount of time, requiring attention 6 days a week for an entire month. Debora and her workers incur an opportunity cost for their time spent shelling, which is particularly high due to it being the harvest season.

Transport is an essential but small part of Debora's journey. Most of her story occurs on the farm or at her house, and she does not need to travel far to access buyers for her peanuts.

### Pains vs. Gains



## Journey 2: Farmer with Access to Mechanization



### Step 1: Going to the Sheller

1.1 Abdallah is a farmer in central Tanzania. He is 28 years old, he lives with his wife and their two children in a village with electricity and running water. He has a farm of 4 acres located 0.5km from his house, where he grows peanuts on 2 acres and maize and millet on the rest.

Abdallah harvests peanuts once per year and reaps a yield of 20 sacks of dried, unshelled peanuts weighing 120kg each from his plot. After he completes the drying, Abdallah hires a neighbor's truck to take him to the nearest shelling machine, located 25km away. His neighbor arrives at 8:00AM in the morning and they spend 10 minutes loading the truck. The drive to the shelling machine takes 60 minutes. Once there, Abdallah and his neighbor unload the truck, which takes another 10 minutes. Abdallah pays him 1,000 TZS (£0.35) per sack, spending 20,000 TZS (£7.00) total.

1.2 The shelling machine is off when Abdallah arrives, which the operator says is caused by a power cut. Abdallah waits around for an hour before he decides to go for breakfast at a nearby food stall. The power still is out when he returns, so he takes the opportunity to socialize with other people that he knows from the community who are also in town. After waiting a total of 5 hours, the power is still out, so Abdallah decides to go home.

1.3 Abdallah talks with the shelling machine operator, who agrees to let him store his peanuts inside the shop. Abdallah is concerned about the security of his harvest, but decides to leave it instead of paying to take them home and back again later. He finds a motorcycle taxi to take him home, and pays him 4,000 TZS (£1.40) for the 45 minute ride.

### Step 2: Shelling Peanuts

2.1 The next morning, Abdallah leaves at 8:00 and returns to the shelling machine on the same motorcycle taxi that he used the day before.

2.2 When he arrives, he finds that the machine is already in operation. After 2 hours of waiting, it becomes Abdallah's turn at the machine.

2.3 Each of Abdallah's bags of unshelled peanuts takes 6 minutes to process and costs Abdallah 1,000 TZS (£0.35). After 2 hours and 20,000 TZS (£7.00), all of Abdallah's peanuts have been fully shelled and placed into bags, filling 7 sacks and totaling 800kg.

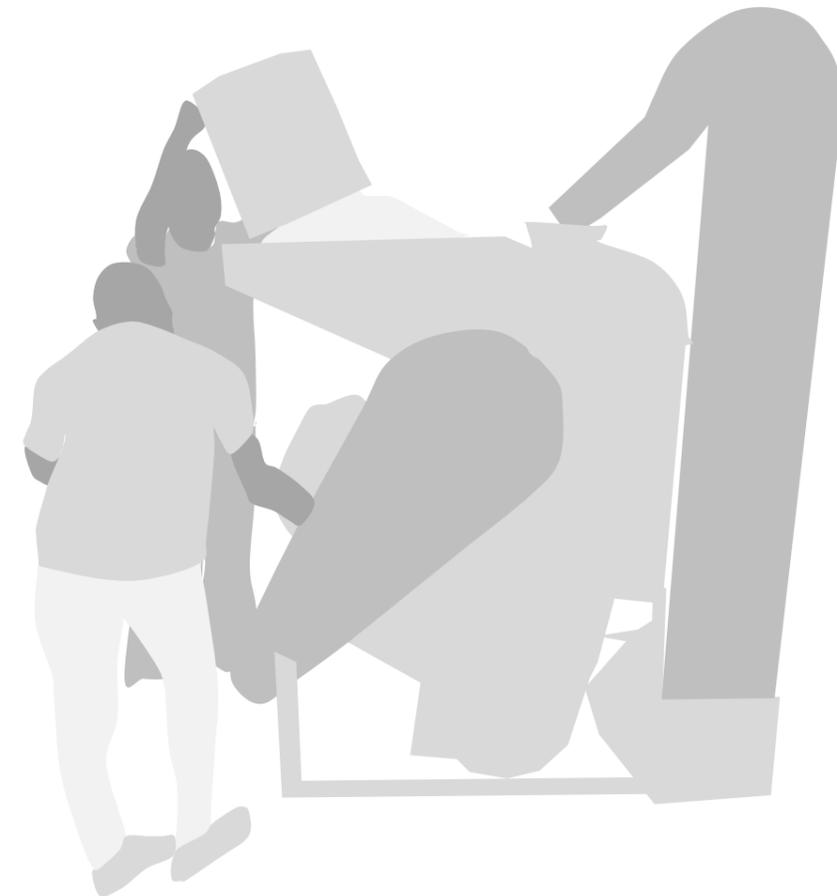
2.4 Abdallah's neighbor is waiting for him when he has finished. Together they spend 5 minutes to load the truck with the 7 bags of shelled peanuts. After the hour long ride home, Abdallah and his neighbor unload the truck for 5 minutes and Abdallah pays him 7,000 TZS (£2.45) for the assistance.

### Step 3: Selling the Harvest

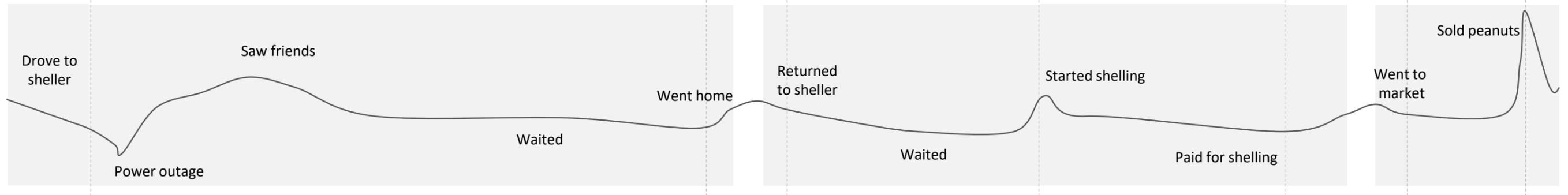
3.1 On the next market day, Abdallah and his neighbor drive to the market together, which takes 60 minutes and costs Abdallah 6,000 TZS (£2.10) for the ride. Abdallah brings 6 sacks weighing a total of 640kg to the market, saving the rest for home use.

3.2 Abdallah spends an hour at the market before he finds a buyer who is willing to pay 2,000 TZS (£0.70) per kilogram of shelled peanuts. Abdallah sells the buyer his 5 bags of 120kg shelled peanuts, earning him a total of 1,280,000 TZS (£448.00).

3.3 His neighbor has more business in town, so Abdallah takes another motorcycle taxi back home.



### Timeline of Activity



### Journey Map

	1.1 Transport Peanuts	1.2 Wait for Power	1.3 Return Home	2.1 Return to Sheller	2.2 Wait in Line	2.3 Shelling Peanuts	2.4 Transport Peanuts	3.1 Ride to Market	3.2 Sell Peanuts	3.3 Return Home
<b>Time</b>	1 hour 20 minutes	5 hours	45 minutes	45 minutes	2 hours	2 hours	1 hour 10 minutes	1 hour	1 hour	45 minutes
<b>Labor</b>	Load and unload truck	-	-	-	-	-	Load and unload truck	-	-	-
<b>Cost</b>	£7.00	-	£1.40	£1.40	-	£7.00	£2.45	£2.10	-	£1.40
<b>Other Pains</b>	-	Leave harvest overnight	-	-	-	20 bags of unshelled peanuts	-	-	640 kg shelled peanuts	-
<b>Gains</b>	-	See friends	-	-	-	640kg shelled peanuts	-	-	£448.00	-

### Assessing Pains and Gains

Abdallah's journey is characterized by his choice to use an on-grid, electric sheller to process his peanuts. Although his journey is slowed by the unreliability of the shelling machine, he ultimately benefits from reduced time, labor, and money in comparison with processing it manually.

Abdallah's activities can be categorized in four main areas: waiting, shelling, selling, and transport.

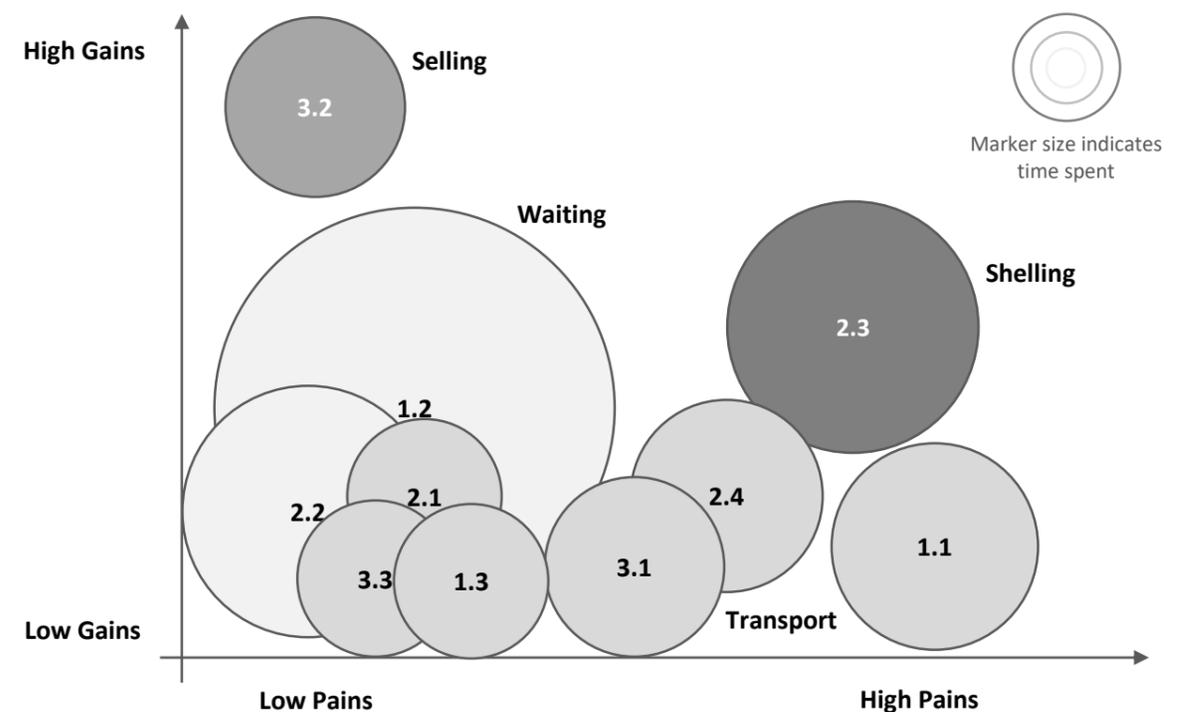
The majority of Abdallah's journey is spent waiting. In this story, most of Abdallah's waiting is caused by a power outage, but this could have instead been caused by a mechanical failure or by a long waiting line. The pain of waiting for Abdallah is both his lost time and the risk that he faces when he leaves his harvest at the shop overnight.

Abdallah's most expensive activity is transport. Despite being relatively near to the shelling machine, his one-way transport charges per bag of peanuts are equivalent to what he spends on shelling. These costs add up, and ultimately Abdallah spends 45,000 TZS (£15.75) and 6 hours traveling.

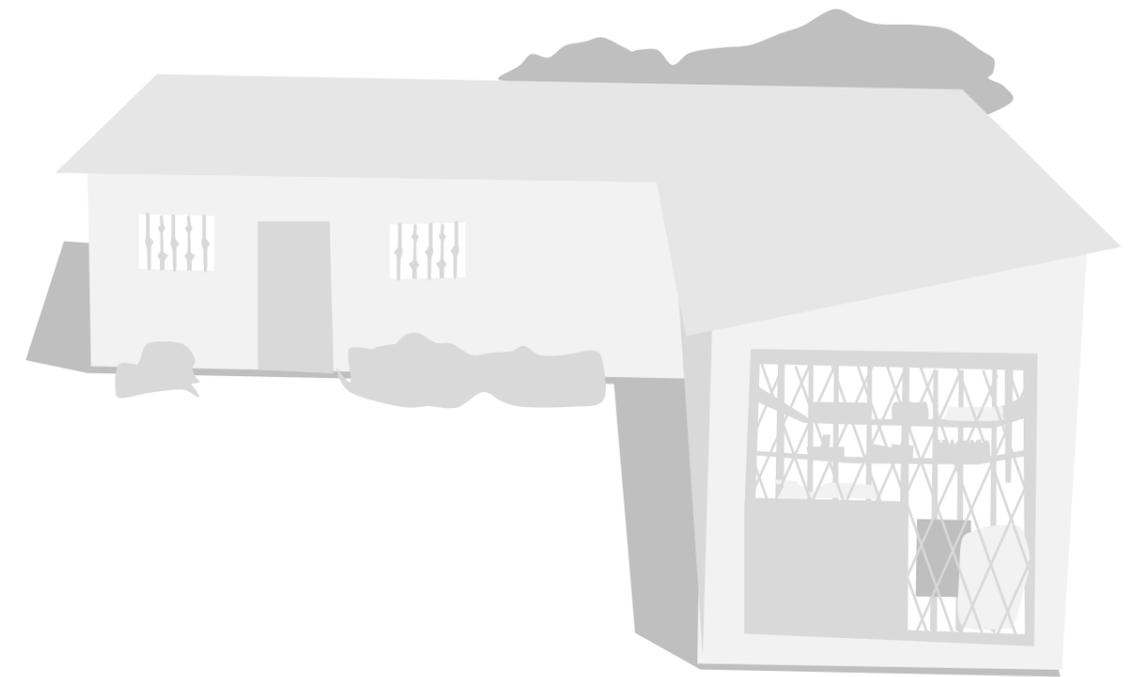
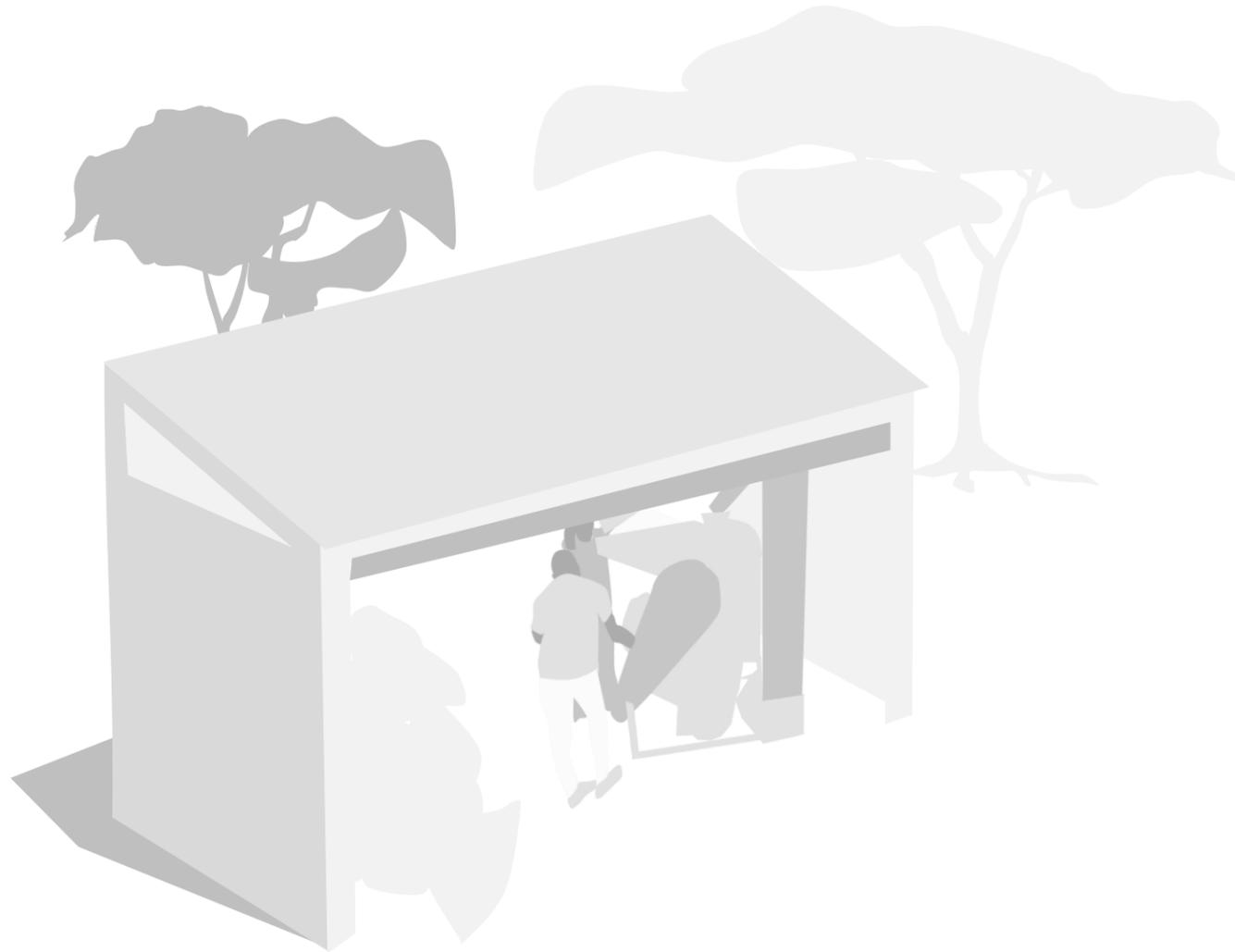
Abdallah's other primary expense is shelling. At only 1,000 TZS (£0.35) per bag, his costs are lower than what they would be if he had paid someone for the labor, and so he uses the machine to process his peanuts for home use as well. For him, the speed of the shelling machine is important not only because of how long he spends shelling but also because of how it affects his waiting time, both of which are 2 hours.

Abdallah's fourth activity is selling. The price is influenced by many factors, such as variety, season, and location. The gains of selling offset Abdallah's pains in the rest of his journey, as well as all of his work planting and harvesting.

### Pains vs. Gains



## Journey 3: Diesel Sheller Operator



### Step 1: Opening the Shelling Business

1.1 Ambilikile is a businessman and farmer in central Tanzania. He lives with his wife and their five children in the town center in a rural off-grid area, which is also where he runs most of his businesses. From his home, he keeps a shop that sells small household goods and items. He also has a small building addition where he keeps and operates a diesel-powered peanut shelling machine, which generates seasonal income for his family.

Ambilikile bought his peanut shelling machine for 3.4M TZS (£1,190.00). The sheller is powered by a 20HP diesel engine that uses 2L of diesel per hour. During the peak seasons (the 3 months after harvest and the 3 months before planting), the machine gets used an average of 10 hours per day. During the low season (3 months between harvest and planting), the sheller only gets used a 2-3 hours per day, and during the off-season (3 months after planting), it doesn't get used at all.

Ambilikile wakes up early in the morning to have his tea and breakfast with his family. At 6:30AM, his two oldest sons help him to open up the shelling business, which already has someone waiting outside with bags of unshelled peanuts. He gives one of his sons 44,000 TZS (£15.40) to purchase 20L of diesel, which he expects to last the day. His other son starts helping the farmer to unload the bags of peanuts from the truck and bring them to the machine. After inspecting his machine for any maintenance issues, Ambilikile starts his sheller at 7AM.

### Step 2: Running the Sheller

2.1 Ambilikile and his sons spend the morning operating the peanut shelling machine. Each hour, they shell 12 bags of peanuts and Ambilikile collects 1000 (£0.35) TZS per bag. Sometimes customers call Ambilikile and he organizes a transport vehicle to come to their farm, which helps ensure that he has a steady stream of customers. At lunch time, Ambilikile and his sons take turns eating lunch while the others run the business.

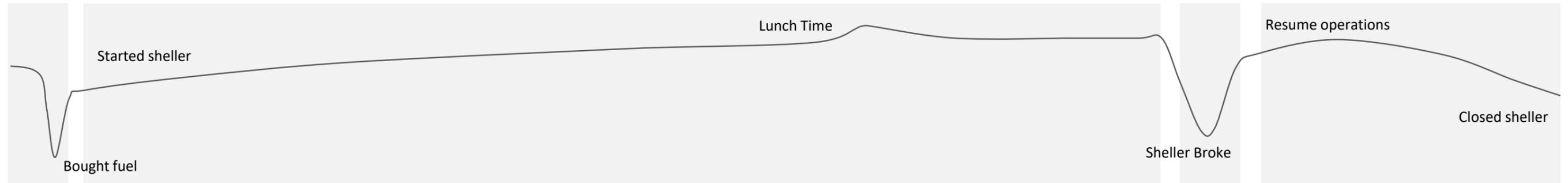
### Step 3: Making Repairs

3.1 The business continues smoothly until the early evening. At 4PM, one of the belts on the machine gets jammed, which brings the entire machine to a halt. Ambilikile and his sons are used to having maintenance issues with their machine and the diesel generator. Replacing the belt costs him only 10,000 TZS (£3.50) and 30 minutes of their time, a small piece of the 200,000 TZS (£70.00) that he spends on maintenance each month. While they do this, one of his sons goes to fetch another 5L of diesel for 11,000 TZS (£3.85), since they still have many customers waiting.

### Step 4: Wrapping up the Day

4.1 After the belt gets fixed, the business starts up again. Ambilikile would like to finish by 6PM so he can have a break, but some of his customers have come from 50km away and he wants their business. At 7PM, he and his sons close up the shop for the night and return back to their home. He keeps the money they earned that day, saving it with his wife so that they can invest it into their household and family businesses.

## Timeline of Activity



## Journey Map

	1.1 Setting Up the Sheller	2.1 Running the Sheller	3.1 Making Repairs	4.1 Finishing the Day
<b>Time</b>	30 minutes	9 hours	30 minutes	2 hours 30 minutes
<b>Labor</b>	Inspect business	Operating machine, loading and unloading bags, supervising	Replace belt, fetch diesel	Operating machine, loading and unloading bags, supervising
<b>Cost</b>	£15.40	-	£7.35	-
<b>Other Pains</b>	-	18L of diesel	-	Staying late, 7L of diesel
<b>Gains</b>	20L of diesel	£37.80	Working machine, 5L of diesel	£10.50

### Assessing Pains and Gains

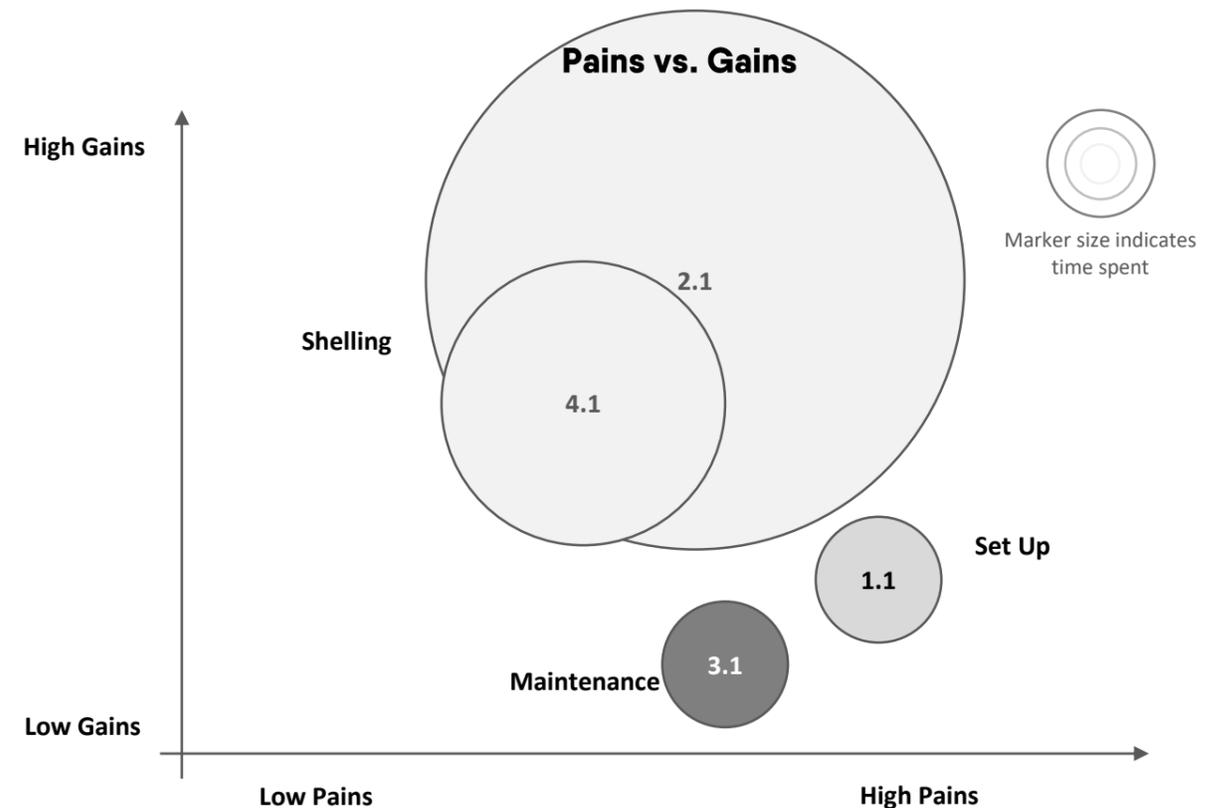
Ambilikile's story highlights the huge, seasonal demand for mechanized peanut shelling services. He and his sons work a 12 hour day serving customers from a wide surrounding area.

Amilikile's journey can be categorized into three main steps: shelling, maintenance, and set up.

The journey starts with setting up the business as one of Ambilikile's sons goes to purchase diesel for the day. While an essential expense, it also costs him almost 50% of the income he earned for the day, representing a big financial pain. Ambilikile isn't bothered by the time and labor required to fetch the diesel: his son does the work for him.

Since it's the peak season, shelling is the most lucrative and time-consuming part of Ambilikile's day. He runs his sheller for a total of 11.5 hours, and during that time has to oversee the operations, help move bags for customers, and collect money. In return for this work, he collects 115,000 TZS (£48.30) in revenue. In other parts of the year, this step would manifest differently: in the off-season, Ambilikile would not run his machine at all, and in the low-season he would only run it for a few hours each day.

Maintenance is another financially painful but necessary part of Ambilikile's day. Although on this day he only spends 10,000 TZS (£3.50) and 30 minutes of his time to fix the belts, over the month this cost adds up and averages 200,000 TZS (£70.00)



# 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 shelling peanuts. By understanding this, we can begin to think about ways to improve the shelling 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**

	Debora	Abdallah	Ambilikile
<b>Proximity</b>	++	+++	+
<b>Speed</b>	+	++	++
<b>Reliability</b>	+	++	++
<b>Affordability</b>	+++	+	+
<b>Breakage</b>	++	+	
<b>Profitability</b>			+++

## Debora’s Journey: Remote Farmer Without Mechanization

Debora’s journey focuses on the sale of her peanut harvest across two different seasons and shows a sensitivity to price. For her, shelling allows her to fetch higher prices for her crops, which is why she pays for shelling services for the crops that she sells. For peanuts that she consumes in the house, she prefers to shell them herself and save the money. Affordability is thus the most important feature of any shelling service that Debora chooses to use.

Proximity of a shelling service is also an important factor for Debora. Although it does not play a big role in her story, it is another expense that she needs to consider if she is to access a mechanized sheller.

We can also expect that Debora is sensitive to any breakage of the peanuts if it effects her ability to sell at a high price.

Less important to Debora are the speed and reliability of the sheller. Although everyone prefers a well-functioning product, Debora is used to spending a month supervising (sometimes unreliable) workers as they shell peanuts by hand.

## Problem Statement

Small-scale farmers like Debora need affordable mechanized shelling services in order to add value to their harvests and increase their annual income.

## Abdallah’s Journey: Farmer Traveling to Access Mechanization

Abdallah enjoys the benefits of mechanization, which he uses to shell his entire peanut harvest. His needs are mostly satisfied by the sheller he uses, but his journey is made more difficult by the 25km journey he takes to and from the sheller.

Proximity is the most important criteria for Abdallah, as he spends more money and time on transport than on the shelling services.

Proximity also heightens the importance of other criteria, such as speed and reliability. When there is a power outage, Abdallah is unable to complete his shelling in one day, which requires him to spend more time and money on transport. Long lines caused by slow shelling speeds could result in similar situations.

The price of the shelling services are less important to Abdallah. At the current price, he is happy to pay for all of his harvest to be shelled, preferring to spend the money rather than do any of it by hand.

## Problem Statement

Peanut farmers like Abdallah need shellers located nearby in order to reduce transport costs and time.

## Ambilikile’s Journey: Sheller Operator

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

The profitability of the sheller is being decreased by the fuel consumptions of the machine. Decreasing the operating costs would help improve the profitability, but it is also important for Ambilikile to have high throughput so that he retains customers and completes his business in a timely manner each day. In conducting user interviews, many sheller operators upgraded their shelling machines with higher power engines to increase the speed.

Reliability is another important consideration for Ambilikile. Machine breakdowns cost him money to repair, but also can result in lost business.

The service charge is another factor that affects profitability, but sheller operators like Ambilikile have shown willingness to set prices at a level that improves their bottom line, even if that means lowering prices. In comparison with manual shelling, mechanized shelling prices are 3 times lower, likely to compensate for transport costs faced by users like Abdallah.

## Problem Statement

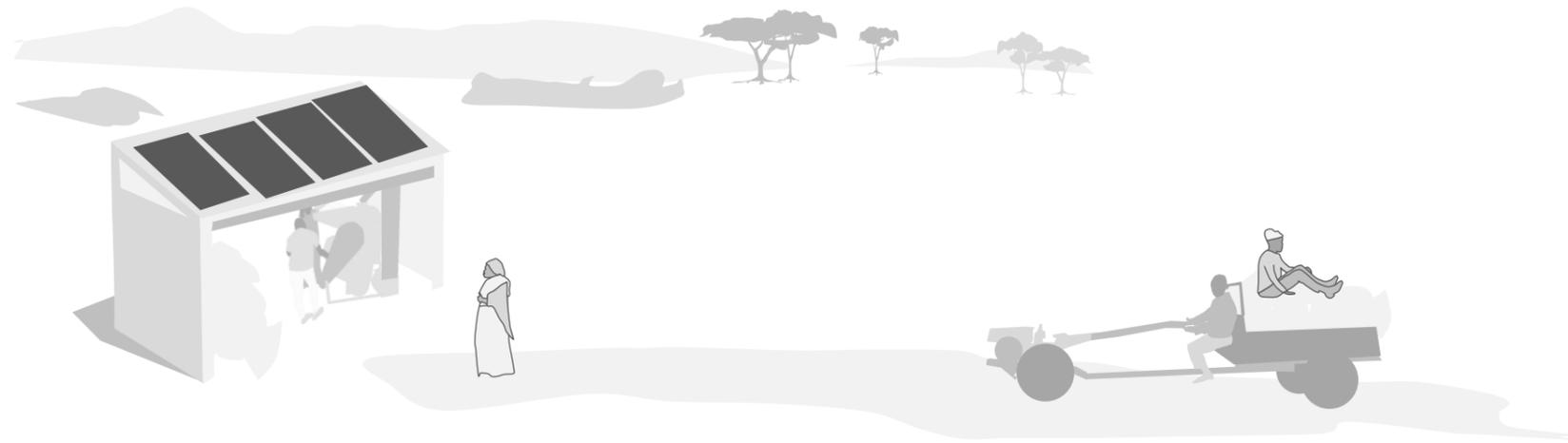
Sheller operators like Ambilikile need to improve trade-offs between cost and performance in their shellers in order to improve their profitability.

# 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 peanut shelling. The next step of the project is to conduct research and development on shelling 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 Solar Sheller

Problem Statement Small-scale farmers like Debora need affordable mechanized shelling services in order to add value to their harvests and increase their annual income

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

### Features

- Proximity: should be located in areas without access to mechanized shelling
- Speed: should be faster than manual methods, ideally can process a farm in one day
- Reliability: should be reliable – remoteness makes repairs very difficult
- Affordability: should be cheaper than paying for manual shelling, after counting for transport costs
- Profitability: needs to be profitable

### Outstanding Questions

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

## Solar Sheller as a Diesel Replacement

Problem Statement Peanut farmers like Abdallah need shellers located nearby in order to reduce transport costs and time; Sheller operators like Ambilikile need to improve trade-offs between cost and performance in their shellers in order to improve their profitability.

Overview of Solution A solar-powered peanut sheller that has throughput equivalent to a diesel model

### Features

- Proximity: should be profitable in remote areas close to farms
- Speed: should be as fast as a diesel sheller
- Reliability: should be extremely reliable
- Affordability: should cost an equivalent to going to a diesel sheller, after accounting for transport
- Profitability: needs to be more profitable than a diesel sheller

### Outstanding Questions

- What is the cost?
- What customer base is required to make the sheller profitable and on what timeline? Can it be profitable when located near users like Abdallah?
- Can a solar-powered machine be cost-competitive with a diesel model? Under what conditions? Over what time frame?
- 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?