Developing a Product-Service-System for the MTego mosquito trap

A graduation report by Bart Janse

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GRADUATION REPORT
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Executive summary

This report describes the results of a thesis for PreMal BV, a start-up company that develops mosquito traps. It is the companies mission to capture anopheles mosquitoes before they can bite and contribute to reducing malaria transmission in Africa and other malaria zones around the world. To be able to achieve their goal, PreMal aims to implement high numbers of traps in the field. This project has been initiated to assist PreMal in their journey towards implementing their mosquito traps as an add-on product to the Solar Home System (SHS) market.

Next to PreMal, SolarWorks! (SW) is the second party connected to this project. This is a SHS distributor that was established in The Netherlands but operates in Mozambique and Malawi, both Sub-Saharan African countries. PreMal partnered-up with SW for the promotion, sales, distribution, and support of their products. This way PreMal gained access to a wide, growing, target group of people that could benefit from their product.

The challenging part of this project was to design a Product-Service-System that was able to connect the two main stakeholders in their wishes and needs while at the same time staying customer centered. To be able to design this system, desk and field research was conducted and literature was supported with field work findings to build a stable framework to build upon.

During the desk research phase information was gathered about SHS, SW, the BoP customer, PAYG-payment models, and PSS. Main findings include that a PSS with a PAYG payment model would suit both the distributing company and the customer. While during field research in Malawi the key findings that arose were related to practical manners such as when people would be able to pay for a product, how they would prefer to pick-up sachets and how the promotion and sales process of the product could look like.

The decisions that had to be made in the design phase were backed by arguments from the desk and field research phases. The PSS that was developed could be divided in six elements that cover the journey of the MTego mosquito trap from development through distribution and use, towards end-of-life. Key decisions were that the product will be sold mainly in a package with a SHS, that odour sachets must be picked up in the stores of SW, that PAYG services will be used to offer contract periods of up to 18 months, and that people that already own a SHS have the ability to buy the product separately with a short, 6-month PAYG-contract.

This report concludes with recommendations for further research that include reducing the price of the product to reach a bigger target audience, developing a smaller and cheaper edition of the MTego for inside use, and research into the best way to create mosquito-free zones in rural communities.

Abbreviations

WUR	Wageningen University & Research
DUT	Delft University of Technology
IPD	Integrated Product Design
SPD	Strategic Product Design
TBM	Technology, Policy and Management
PreMal	PreMal BV
SW	SolarWorks!
SSA	Sub Saharan Africa
BoP	Bottom of Pyramid
SHS	Solar Home System
PUE	Productive Use of Energy
Wh	Watt-hour
PSS	Product Service System
WHO	World Health Organization
UN	United Nations
DP	Down payment
USP	Unique Selling Point
PAYG	Pay as You Go
COGS	Costs of Goods Sold
NGO	Non-Governmental Organisation
FOB	Free On Board
CRM	Customer Relationship Management

Key definitions

Contract price The price of a product or package increased with the interest and risk factor that will be applied based on the duration of the contract.

Down Payment The first payment of a contract that covers for the costs of promotion, sales, installation and repossession of a product.

Free On Board According to international trade law, the seller organises and finances transport from factory to ship, and the responsibilities move to buyer when loaded on the ship.

Gross margin The difference between revenue and costs of goods sold, divided by revenue.

Interest and risk factor PAYG loans have an interest and risk factor that is applied to cover for the chance that the loan can not be payed back.

Landed cost The price of a product, when it arrived in the country of destination. The landed price of formed by the purchase price of a product with the costs of shipping, handling, import taxes and excise duties added to it.

Non-Governmental Organisation An organisation that is independent from the government and that generally operates for societal or humanitarian causes on a non-profit base.

Normal price Normal price or price is the price that a customer pays for a product or package if it will be payed at once.

Odour sachets PM6 odour sachets developed by PreMal BV to attract mosquitos with the MTego mosquito trap.

Package price The total price of a package of products.

Pay as You Go A method to pay for a product by paying for it's use. All payments together form the total sum of money that must be payed for it, spread over a chosen amount of instalments.

Price elasticity The degree to which the demand for a product changes whenever the price changes.

Purchase price The price that SW pays to acquire goods that can be sold later. This price is the same as COGS.

Selling price It is the price that SW receives upon the sale of their products to customers.

Vector control Methods to reduce the amount of mammals, birds or insects that spread diseases. The most popular vector control methods are aimed at fighting mosquitos.

Watt-hour One watt of power expended for one hour

Introduction

It was early 2018 when Henry Fairbairn started working with WUR researchers Florian Muijres and Antoine Cribellier to develop an odour baited mosquito trap that had a higher capture efficiency then the traps that were available at that time (Fairbairn, 2018). Fairbairn developed a first version of the MTego during his graduation project for the IPD masters at DUT. He started to value his solution and decided to found PreMal BV, together with his business partner that could help him with the business side of the project. Fiori was capable of working on this side of the project because of his background from the TBM faculty in Delft and he also had previous experience with another start-up.
After Fairbairn graduated, Cedric van de Geer, another IPD student, started his graduation project in which he developed a second version of the MTego that included design and embodiment improvements (2019). In this project, van de Geer performed semi-field tests in Kenya and was able to improve the user interaction of the trap together with a reduction of the production costs.

PreMal's mission is to capture anopheles mosquitoes before they can bite and contribute to reducing malaria transmission in Africa and other malaria zones around the world. Previous research has shown that mass trapping considerably reduces mosquito populations resulting in up to 30% reduction in malaria cases (Homan et al., 2016).
PreMal aims to make mosquito traps commercially viable in the low income market to achieve a high coverage of traps in rural malaria areas. However, selling new products to new markets, and especially BoP markets in SSA, is a challenging assignment. PreMal has no distribution channels in place in these areas. The product is about as expensive as one month of salary for most people and the potential customers perceive the value of the product as low because they are not aware of the potential benefits. These and more challenges were to be addressed during this project.

To be able to start generating revenue whilst in the process of reaching BoP customers, PreMal decided to target the hospitality market first. The company got into contact with distributors that sell products to pest control companies throughout malaria zones around the world. This resulted in sales and contracts with hotels and restaurants aimed to protect their guests from mosquito annoyance.

PreMal made the choice to introduce their product to their second market by to partnering-up with SolarWorks!, a solar home system provider. Both companies agreed that in order to streamline the market introduction of this new product in a new market, a Product-Service-System had to be developed. This PSS is a detailed plan on how the MTego could be added to the product portfolio of SW and how their customers should experience the promotion, sales and use of it. This marked the start of my SPD graduation project; I became responsible for writing this strategic plan, making it as enforcable as possible to help both companies reaching their goals. This MTego PSS graduation project has to be customer focused because that is important when designing for the world's less fortunate people (Boeijen, Daalhuizen, Zijlstra & Schoor, 2020).

During this project, I got offered the chance to travel to Malawi to perform the field-research necessary to develop this system. I was able to join Fairbairn for the duration of three weeks in the month of February 2020. PreMal organised this trip to investigate the effectiveness and technical qualities of the MTego during a month-long trial, while I focused on the people and business side of the introduction of the trap.
This report describes and illustrates the background research, field research, and design and development phases that have been gone through to make the project a success.

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FIGURE 1: **PEOPLE INVOLVED IN MY GRADUATION PROJECT**

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1. Project

This chapter provides an introduction to the project. It addresses the contribution of the project to the introduction of the MTego as an add-on product to the SHS market. It encompasses an overview of the project through setting objectives, defining phases and elaborating on design approach.

Project brief

The aim of this project is develop a PSS for the MTego in the low income market as an add on product to the SHS market. This means that all possible aspects that come with the introduction of this product to this market will be touched upon. It means also that this plan has a wider scope than a marketing plan as it includes payment methods and plans, advised product packages, tactics for storing and distributing (parts of) the product, a promotion plan and starting points for transport, logistics, subsidy, warranty, and repairs.

This PSS must solve the problems that come with selling a new product to BoP people in SSA: PreMal has no distribution channels in place. The product is about as expensive as one month of salary for most people, and the potential customers perceive the value of the product as low because they are not aware of the potential benefits. The MTego PSS should be developed with customer focus to be able to fit in their context properly. In order to develop this system, both desk- and field-research will be performed and synthesized into a final proposal. Figure 2 shows the objectives that need to be achieved to achieve the end goal of the project.

Now that the MTego Mosquito trap is ready for mass production, PreMal partnered-up with SW to reach their second target group. The product needs a stable source of energy to run on, thus the choice for a SHS provider. PreMal needed a distributing partner while, as a start-up, the company does not have the power to build a distribution infrastructure, sales agents, and a client base themselves.

The goal to reach within the time-frame of six months is to develop a first version of this PSS as a basis for further negotiations between PreMal and SW. It is my personal goal to make a plan that suits both companies and that it will be implemented without much changes. This would mean that SW starts selling the MTego taking into account the advice provided in this report.

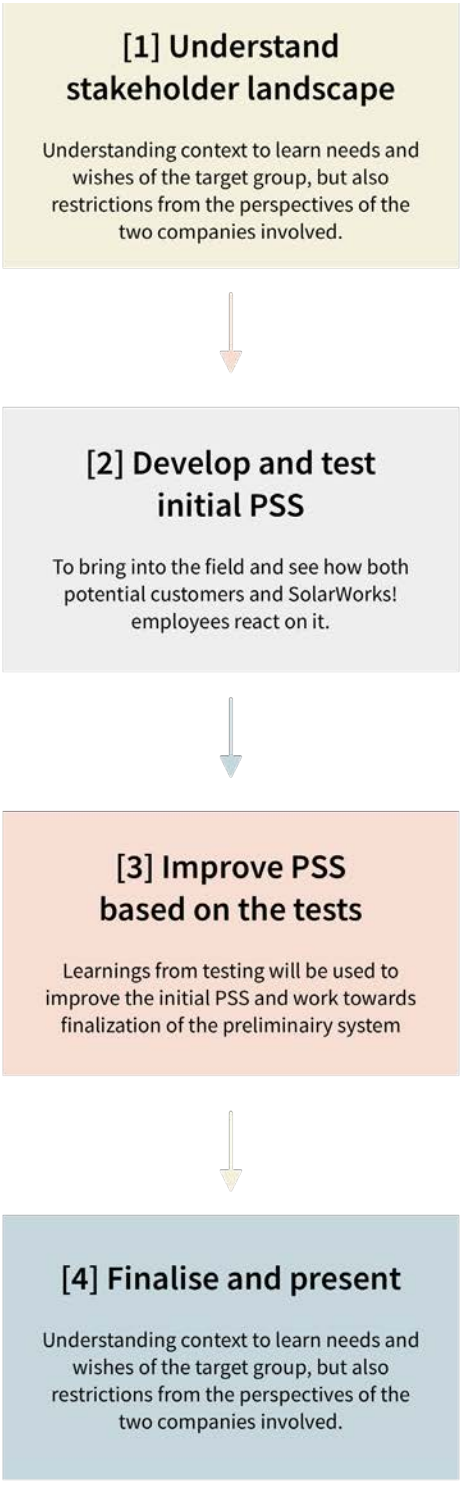


FIGURE 2: **PROJECT OBJECTIVES**

Project approach

To structure the decision making process and keep an overview on which decisions were already made and which still have to be made, the process tree by Roozenburg & Eekels (1998) and the agile feedback loop by Beck, Beedle, Van Bennekum, Cockburn, Cunningham, Fowler & Kern (2001), were combined and used to approach this process through a theoretical lens.

PROCESS TREE

A process tree can be used to get an overview of the lifecycle on a product. A product cycles through four different phases that were originally designed to be stage-gate processes followed in chronological order. According to the process tree model, a product moves through following phases (translated from Dutch): originate (1), distribute (2), use (3), and disembody (4).

This tree was chosen as main frame because it forces the designer to think of possible solutions and helps detecting knowledge gaps (Roozenburg & Eekels, 1998). Figure 4 on page 16 shows an adoption of the model and projects how the MTego PSS project fits in there. The project's main goal, being the development of an early version of a PSS to be used to distribute the MTego, is reflected by the placing of it in the model. This model shows how the project is primarily focused on the distribution link of the chain (2), while it touches upon the originate (1) and use (3) links as well. The project challenges for example the design and use of the product based on research.

FEEDBACK LOOP

After the introduction of the Agile Manifesto by Beck et al. (2001), the general consensus about new product development changed and Agile methodologies were introduced that advise for short feedback loops; loops of which results are used to update previously set requirements. During this project, these iterative loops have also been applied.

This project was initiated because PreMal needed a strategic solution to be able to introduce the already designed and developed MTego to their second market. The nature of the project implies that several decisions had already been made upfront. For example decisions about a partnership with SW, the target group, and the use of a PSS. These decisions are to be considered as starting points of the project. Although these starting points were already set, they have been challenged in the research phases and some have been adjusted.Figure 3 illustrates how the Agile feedback loop (Beck et al., 2001) was applied.

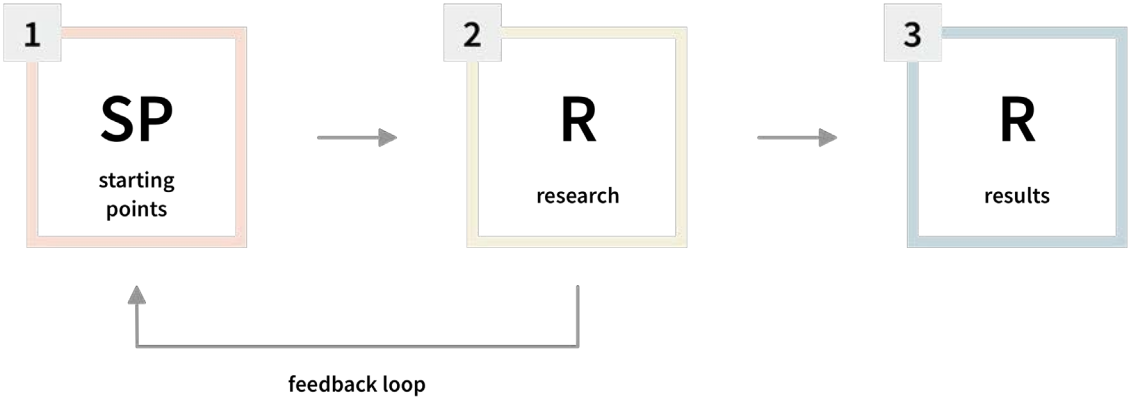


FIGURE 3: **FEEDBACK LOOP**

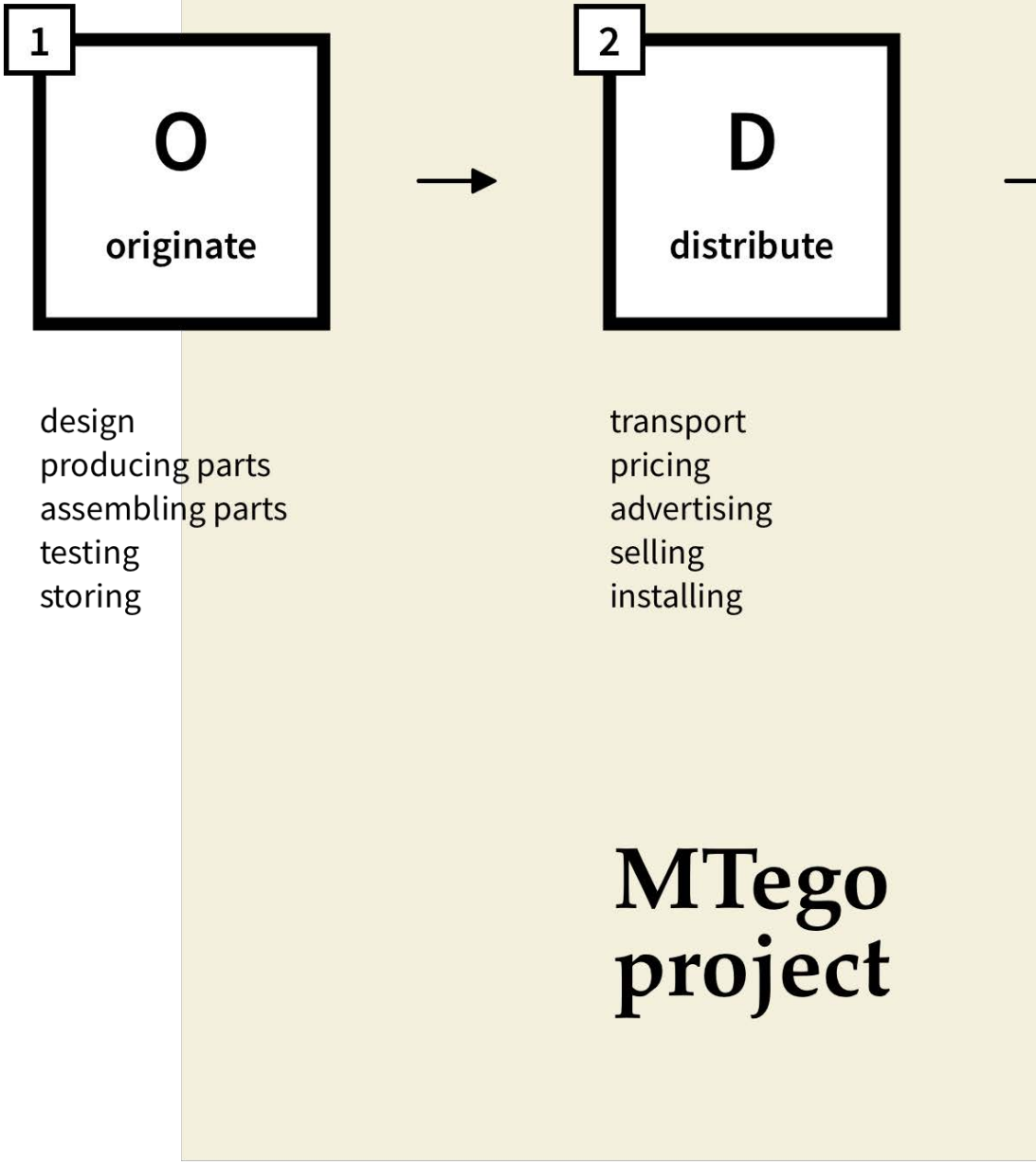
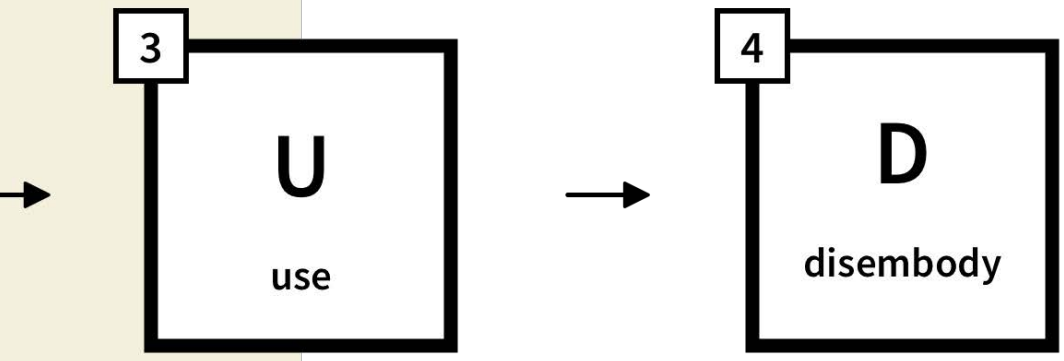


FIGURE 4: **PROCESS TREE (ROOZENBURG & EEKELS, 1998)**



turning on/off
cleaning
maintaining
repairing

transporting
disasembling
reusing
recycling

About the MTego mosquito trap

The MTego (Figure 7) is an odour baited mosquito trap which replicated human characteristics to attract mosquitoes. The trap employs a counter-airflow principal which uses an electric fan to create suction and emit a plume of odour. Mosquitoes follow the odour plume to the source and, on approach, are sucked into the cat-pot, see Figure 5. Because of the fan, the product needs electricity. This can be provided either by a SHS or by plugging the product in a wall socket with a 12V transformer.

Next to electricity, the trap uses a PM6 odour sachet that has to be changed every three months for optimal functioning. This is an insecticide-free bait that attracts mosquitos to the trap, mimicking human smell such as sweat. Mosquitos can smell humans from up to a 30 meter distance, Figure 6 shows how they are attracted to the house. The PM6 smell is more attractive to mosquitos than that humans are, therefore PM6 can lure mosquitos towards the MTego whenever they get close to the house.

The MTego will most likely go into mass production in eastern Europe, where all parts will be fabricated and put together. From there, it can be shipped to any location in the world. The PM6 odour sachets are being produced in the United Kingdom and can also be shipped to any location in the world, separately from the traps.

The way that this product has been designed and developed makes it difficult to make fundamental design adjustments. Changes to key features should be tested before implementation. Testing requires mosquito rearing and lab time which is difficult to get for commercial parties like PreMal BV.

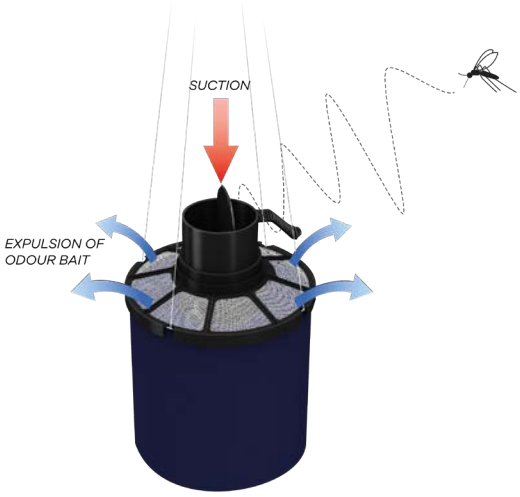


FIGURE 5: **SCHEMATIC DRAWING OF COUNTERFLOW TECHNOLOGY**

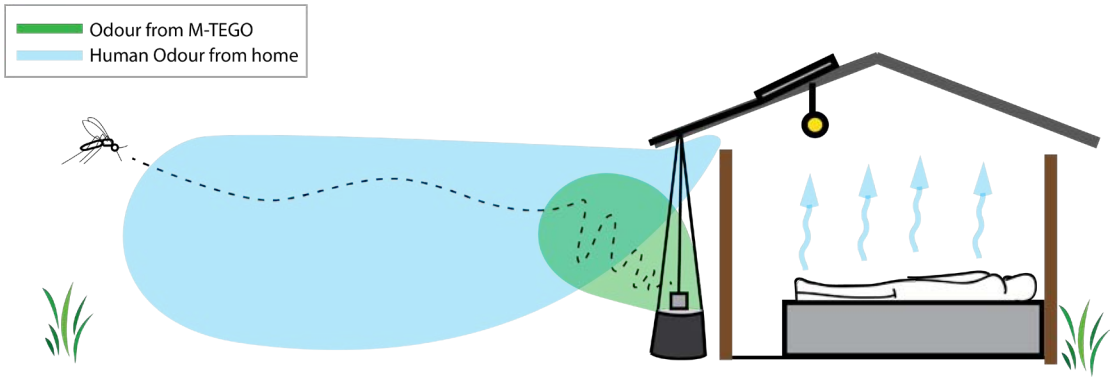


FIGURE 6: **SCHEMATIC DRAWING OF MTEGO PRINCIPLE**

FIGURE 7: **PHOTO OF MTEGO IN KENYA**

2. Background

This chapter describes the conclusions based on desk research. The main aim of this phase was to understand the stakeholder landscape. Journals and online articles were read, and case studies were conducted to acquire an overview of the Solar Home System market, the Base of Pyramid customer, PAYG-services and Product-Service-Systems.

Solar Home Systems

As the price for solar energy has decreased in recent years, solar home systems became affordable to people living in rural areas without a connection to the centralised energy grid. SHS provide people with light at night, a charger for their mobile phone and power for a small TV set. The impact that these systems make globally is far-reaching. This chapter takes into consideration what these systems are, which categories exist, what the global impact is, and the potential market for SHS.

WHAT IS A SHS?

Solar home systems are flexible stand-alone systems that consist of a photovoltaic solar cell, a battery, and a charge controller that protects the battery from overcharging. See Figure 8 for a SW product advertisement with a SHS. These systems are able to power energy efficient appliances such as lights, radios and small TVs. Usually, a SHS operates at 12V DC power but inverters can be connected to change the current to 240V for larger appliances such as fridges and freezers. A SHS is able to fulfil the basic energy needs of a family living in a rural area and can substitute dirty sources of energy such as kerosene and cow dung.

SHS CATEGORIES

SHS can be categorised in categories of increasing capacity, see Table 1 for an overview (Adelmann, 2015). The systems that SW sells are to be categorised as small SHS (40Wh) and advanced home systems (115Wh & 400Wh). Several years ago, SW developed a solar lamp that could be screwed through a corrugated iron roof, that product was a pico system. However, the company decided to focus on distributing bigger systems after they had been advised to do so.

GLOBAL IMPACT

The impact of the growth of the SHS market globally to the well-being of BoP people is big because of the multiple benefits that come with these systems. According to the Off-Grid Solar Market Trends Report it can be concluded that SHS are a positive addition to the lives of people living in rural areas. (International Finance Corporation, 2018):

- People around the world saved cumulatively approximately €4.7 billion by not buying conventional fuels.
- Improved health reported by 45% of SHS users who previously used kerosene, especially regarding respiratory and eye issues, and reductions in burns and accidents.
- An estimated 28.6 million tons of greenhouse gas emissions have been avoided by not using dirty sources of electricity, but when considering all solar powered devices around the world, this number is likely to be higher.
- SHS can support income generating activities which improves the financial position of people.

MARKET GROWTH

Between 2010 and 2017, the potential global market for SHS grew with an estimated 20 million households to 434 million (International Finance Corporation, 2018). Main reasons for this market growth are that many people that have been connected to the grid in these years, have an unstable connection (1), that the population grows rapidly in rural areas (2), and that about 120 million people are ready to replace or upgrade their current systems (3). It is to be expected that this market continues to grow by these drivers. The SHS market potential is big and even if PreMal reaches only a small percentage of these people, many traps can be sold.

Amount of energy per day	Applications
< 10 Wh	Pico solar systems such as solar lanterns, small telecommunications receivers, and small road signs
<100 Wh	Small solar home systems, medium telecommunications systems, road signs, and streetlights
<1 kWh	Advanced home systems, large streetlights, schools
<10 kWh	Farms, global systems for mobile communications repeaters, large schools, health posts
<100 kWh	Mini-grids, large rural hospitals

TABLE 1: **SHS CATEGORISED IN POWER DEMAND - ADELMANN (2015)**

FIGURE 8: **SW MALAWI SHS ADVERTISEMENT**

SolarWorks!: a brief overview

SolarWorks! started in 2008 as a YES!Delft startup by Arnoud de Vroomen and Bernard Hulshof. The company was created around the Solar Power Ball that was a standalone product capable of charging mobile devices and provide light at night. Other products were added and at some point, the owners decided to change their role from a producing company to a distributing company. The reasons behind this change were the difficulty to meet big (Asian) manufacturers prices and the potential growth of the company when distributing products of others.

ABOUT THE COMPANY

SW started distributing SHS and add-on products like radios and TVs in Mozambique and opened-up a branch in Malawi in 2019 as well. Their distribution headquarters are situated in Johannesburg in South-Africa in order to be close to the market. SW management headquarters are situated in Rotterdam, The Netherlands. Currently SW has over 22.000 customers in Mozambique and over 1.500 customers in Malawi.

Three interviews with managers from SW were conducted. These interviews were held to receive an overview on how the company operates, what the company finds important and which products are sold most. For this project Thomas de Wijn (Operations Director), Bram Rozestraten (Operations Manager Malawi), and Bob Phondo (Sales Manager Malawi) have been interviewd. The findings presented in the upcoming paragraphs followed from these three interviews.

PRODUCT PORTFOLIO

Starting in 2020, SW updates their current product range with three main products being the SW20, SW80, and SW155, of which the latest is capable of suppling enough power to run a refrigerator. The number in the package title stands for the amount of Wh that the products deliver. The system that is sold the most is the SW80 system without a TV. See Table 2 for the current Malawian product portfolio with prices converted to Euro. SW plans on adding multiple add-on products to the product portfolio. Potential add-on products are: a sewing machine, a refrigerator, a freezer and a water pump. Of these products, the freezer is the most desired one. Currently, it requires a larger SHS than the target market can afford to supply for a freezer, but the price per Wh is decreasing rapidly so SW is confident to be able to deliver according to this demand in the near future.

SALES

To promote and sell products, the Malawian part of SW employs about 40 full-time sales agents. These agents host events at local villages to attract villager's attention. If a contract is signed during these events, the purchased system can be installed within a week. The customer pays the down-payment directly to the installer by cash or using mobile money beforehand.
Next to sales events, SW products can also be bought at the stores and offices of the company. As it is common for people to bring a flyer home from a sales event to discuss potential purchase with family members before deciding on purchase, the village centre stores are an important part of the SW sales infrastructure.

Product	**Cash price**	**PAYG**	
		Down payment	*Monthly payment*
SW20	€103,00	€7,50	€5,60 x 24m
SW80 Lite	€188,00	€17,50	€8,75 x 30m €12,50 x 18m
SW80 + TV	€541,90	€52,50	€26,25 x 30m €37,50 x 18m

TABLE 2: SW PRODUCT PORTFOLIO 2020

FIGURE 9: **SW LOGO PAINTED ON A WALL**

MAINTANANCE

The business model of the company is to provide SHS and add-on products with loans up to 30 months. This model implies that customers expect service for the duration of their contacts. Between 80% and 90% of the service requests can be handled and solved over the telephone. Most customers call or SMS the company, while others withhold payment and wait for a call. The company policy is to fix issues within 7 days so that multple requests can be gathered within one area before visiting. In Mozambique, every month about 2% of the client base needs to be visited for service. In case of theft, a police report is needed before replacing the system.

CONTRACTS

SW sets a minimum of 10% down payment for all PAYG contacts, followed by monthly payments of the resulting contract price of the agreed period. This down payment is asked for to cover the cost of sales, installation and potential repossession of the product. Customers are able to pay a down payment of up to €15 directly out of their pocket. For products with low value, short payments plans can also be created which reduce the risk of non-payment. Mobile banking services are used to have customers pay their monthly instances without having to physically go to the store or pick-up the money. These services can add up to 7.5% of the product cost to the customer due to fees. SW does not exclude customers that do not have acces to mobile banking services, these customers can pay monthly installments in cash at the store. Customers can pay upfront for as long as they want to, this happens around May and June when farmers harvest and sell their crops.

INTEREST RATES

Customers in Malawi are unable to receive loans from formal banking institutions due to the lack of anything to provide as collateral to the loan, and the lack of anything to prove stability of their income. The loans that SW provides come with a high risk which makes it relatively expensive. The total costs of spreading a sum of money can go up to 52% when opting for a 30-month PAYG lease (see Table 3). When people are not able to pay a monthly instalment, the system turns itself off. If people have not paid their monthly instalment for over 60 days, SW will reposes the system.

Contract period (months)	**Yearly interest and risk rate**	**Total interest and risk rate**
18	14%	21%
24	19%	38%
30	21%	52%

TABLE 3: **INTEREST AND RISK RATES FOR DURATION OF CONTRACTS**

Base of Pyramid Customer

In 2016 in the region of Sub-Saharan Africa, 60% of people did not have access to electricity (Arlet, Ereschenko, & Lopez Rocha, 2019). With just over 1 billion people living in this region (Plecher, 2020), about 648 million people face barriers to clean energy access. However, most of these people do have access to a mobile phone and are able to make micro-payments. These people are targeted for a SHS and will be the target group for the MTego as well.

ABOUT MALAWI

Malawi is a land-locked country in Southeast Africa. Until 1964 the land was colonised by the British and it was called Nyasaland. It took until 1994 to introduce a democratic multi-party government system. Although Malawi's democratic system, one of the countries biggest problems is corruption. The leading international NGO that fights corruption defines corruption as: "Corruption is the abuse of entrusted power for private gain" (Transparency International e.V., n.d.). Malawi loses about 30% of its public resources due to it. In 2013 a big scandal came to light and was referred to as the Malawian Cashgate Scandal. This scandal had a negative snowball effect as the country relied heavily on investors and donors; Malawi receives about 40% of its annual budget. Donors became hesitant because of the uncertainty that their money would be well spend.

Being responsible for 80% of the economy, the country relies on agriculture as its main driver. The main crops that are grown are tobacco, tea, sugar, corn, soy beans and nuts. Malawi has about 19 million inhabitants (2020) and a surface area of 118000 km^2 land with 20% water, the country is about three times the size of The Netherlands and has about the same amount of inhabitants. The population density is low.

BASE OF PYRAMID

The people targeted in this study have very little disposable income, to give an idea of the amount: with a nominal GDP of 340$ per capita, the average Malawian has less than 1$ to live off per day. It should be noted that purchasing power is different in Malawi. Goods that would cost $1,00 in the United States (US), will cost $0,28 in Malawi according to the currency +/- value index (Global Property Guide, n.d.). That means that the people that have $1 a day in Malawi, theoretically would be able to buy as much people that have $3 a day in the US. The average Malawian is living in extreme poverty, below The World Bank's benchmark of less then $1,90 per day (The World Bank, 2018).

Although the target group does not have their own energy connection, most of them do have a mobile phone with which SMS messages can be exchanged. Like people in western countries, BoP people have found the benefits of quick mobile communication to be of high importance. A mobile phone can be found in almost every household, even when they do not have enough to eat. Having the ability to send and receive SMS messages is a requirement to be able to use a PAYG system, and thus being able to become one of SW clients.
People in Southeast Africa are getting used to mobile money fast; the majority of Malawians used mobile money services instead of conventional banking services in 2017, and this number is growing by the day.

According to an interview with a manager of SW in Malawi it is easy to show potential customers what a SHS can do to their house (B. Rozestraten, personal communication, 18-12-2019). Turning on the lights at night for many provides possibilities that have not been present before. However, the assumption is made that it will be difficult to explain the target customer about the long term benefits of the MTego. The short term benefits are clear and easy to show; people will get bitten less so less mosquito nuisance will be experienced. The most important long term benefit is the potential decreased risk of child mortality, together with the cost savings on medicines and decreased productivity. Rozestraten also explained that often people see these risks and costs as part of their life and are generally not open to change.

The amount of money spend on out-of-pocket health expenditures lies around 8% to 10% of the yearly family budget for BoP customers. To place this in perspective, in the United States, anything above 5% of the family income would be considered unaffordable (Ketelaars, 2015).

ENERGY POVERTY

In the continent Africa, still many people do not have access to clean energy sources. People use crop residues or dry dung to burn and extract the energy from. The advantage of these sources of fuel is the reuse of waste, however the disadvantage is the air pollution that goes with it. People that use these primitive types of fuel are considered energy poor. In Africa, still many countries face energy poverty. Kaygusuz developed an index to measure the energy poverty of a country by taking into account the amount of people that face a certain acuteness of energy poverty (2011). His MEPI score ranges from 0.90 in the most energy poor countries (Ethiopia) until 0.01 where energy poverty eradicated (Egypt). Malawi (0,87) is in top 5 energy poorest countries of Africa, together with Ethiopia (0,90), Niger (0,88), Mozambique (0,87), and Uganda (0,87) (see Figure 10).

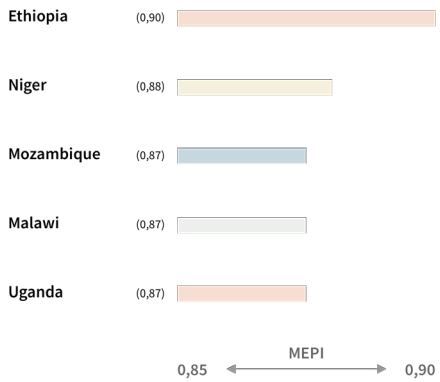


FIGURE 10: **ENERGY POVERTY INDEX - KAYGUSUZ (2011)**

Energy poverty is caused by barriers to clean energy. These barriers could include that the infrastructure is not in place, but also that cleaner energy generally speaking needs a bigger investment - although it often is cheaper per unit. The energy ladder (Leach, 1992) is a common model to describe household fuel choices. People 'climb up' over the ladder until they are able to use gas, electric, and renewable energy sources. Van der Kroon, Brouwer, & van Beukering describe three categories of fuels being: primitive fuels (1), transition fuels (2), and advanced fuels (3) (2013). The researchers highlight that people generally not climb this ladder one fuel type at a time but that people use a combination of sources, based on their availability. Thus, Van der Kroon, Brouwer, & van Beukering rather call the energy ladder, the energy stack (see Figure 11).

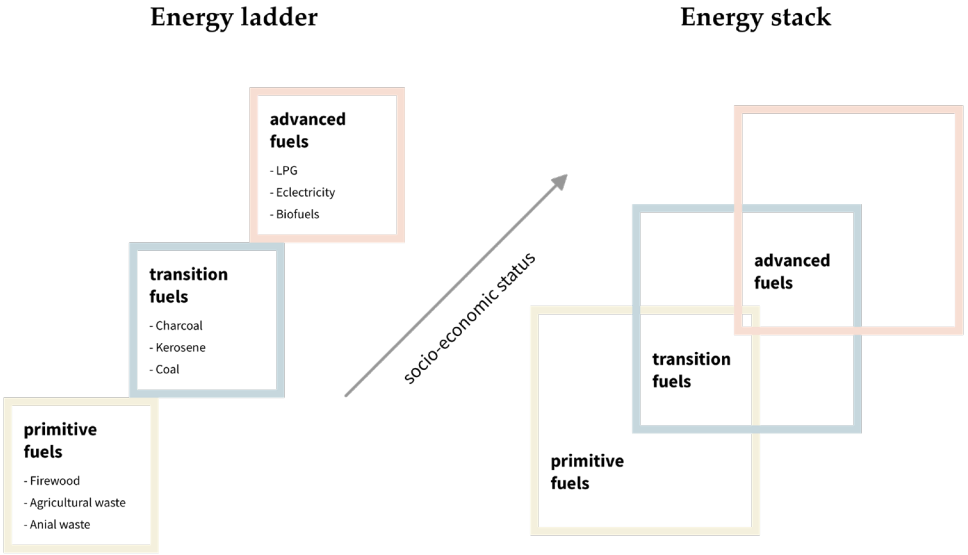


FIGURE 11: **THE PROCESS OF ENERGY TRANSITION (VAN DER KROON ET AL., 2013)**

FIGURE 12: **MOSQUITO BITING A HUMAN - PHOTO BY JIMMY CHAN**

MALARIA PROBLEM

The World Health Organization communicates in their World Malaria Report that in the world, 435 000 people died from malaria in 2017, of which most of them were in emerging economies in Africa (2018). Malaria is an infectious disease caused by the unicellular parasite of the Plasmodium gender. Female anopheles mosquitos spread this parasite, therefore they are also referred to as malaria mosquitos. Of all people that die from this disease, 61% are children under 5 years old. Although modern medicines and improved healthcare infrastructure has had a positive effect on fatalities, there are still over 200 million cases of malaria recorded in Africa each year. This in turn has an economic cost of around 12 billion dollar per year across Africa considering direct and indirect costs of malaria prevalence.

Most people tend to self-diagnose when the symptoms of malaria occur, bypassing the formal healthcare system. People buy medicine against the disease while many are not infected, these medicines will not work. In a study by Cohen, Dupas, & Schaner it was found that only 37% of the people that self-diagnosed was tested positive on malaria, the people had a different illness which required a different treatment (2015).

The Malaria disease comes with pressing consequences; physically there are death and severe illness, while materially there are the costs of hospitals, medicines, and lost labour. In order to reduce malaria transmission. Vector control methods have been developed. Vector control methods methods reduce transmission by temporarily reducing the amount of mosquitos. Some examples are: mass trapping, indoor residual spraying, insecticides, and insecticide treated nets (van de Geer, 2018).

Pay-as-You-Go payment model

The prepaid payment model Pay-As-You-Go has been developed to make previously unaffordable products or services available to a broader public. The model has been adopted by off-grid energy suppliers in Africa and has become the main method for financing in Sub-Saharan Africa.

WHAT IS PAYG?

PAYG is a payment model that is used to provide products or services to people that do not have access to a bank or other financing services. In this model, a user buys credits for a certain amount of money that could be missed at that point in time. With these credits, the user unlocks the product or service that could be used until the credit is diminished. Figure 13 shows how a journey through the PAYG system could look like from customer perspective. Figure 15 on page 31 shows examples of PAYG products.

Within PAYG, two types of models are possible. These models are either rent-to-own (1) or fee-for-service (2). In the first model, the user pays a certain number of instalments until the total price of the product and service is paid off. In the second model, the user pays for the service as long as the service is needed. In both models, payments could be either 'per period' or 'per use' where a period could anything between a day, a week, a month or a year and a use could be either 1 session or a specific amount of something. SW uses the rent-to-own model where the customer acquires ownership of the product after the contract period.
M-Pesa is the biggest mobile money service in the world, it is used in seven countries in Africa but not in Malawi. In Malawi, the two available mobile banking services are called Airtel Money and Mpamba. With these services, people are able to buy credits at local agents in villages with cash, which then can be transferred to their mobile phone accounts. The mobile money can be used to pay for PAYG credits, but also to buy food, other necessities, or to transfer to family and friends. At least 1.5 million Malawians were using mobile money services compared to the 1.2 million formal bank customers in 2017 (Nyirongo, 2017).

BENEFITS OF USING PAYG

PAYG offers benefits for both the customer and the distributor. It makes previously unavailable products available to customers by providing the opportunity to pay in monthly instances. A BoP customer is generally not able to buy a €300,- SHS in cash; only 5% of SW's contracts are paid in cash, of which most of them were the entry level system (SW40 - €103). The customer benefits from having the ability to buy a SHS with a loan because these systems offer them:

- Improved health by not burning conventional fuels
- Economical benefits by cutting costs of conventional fuels
- Support in income generating activities

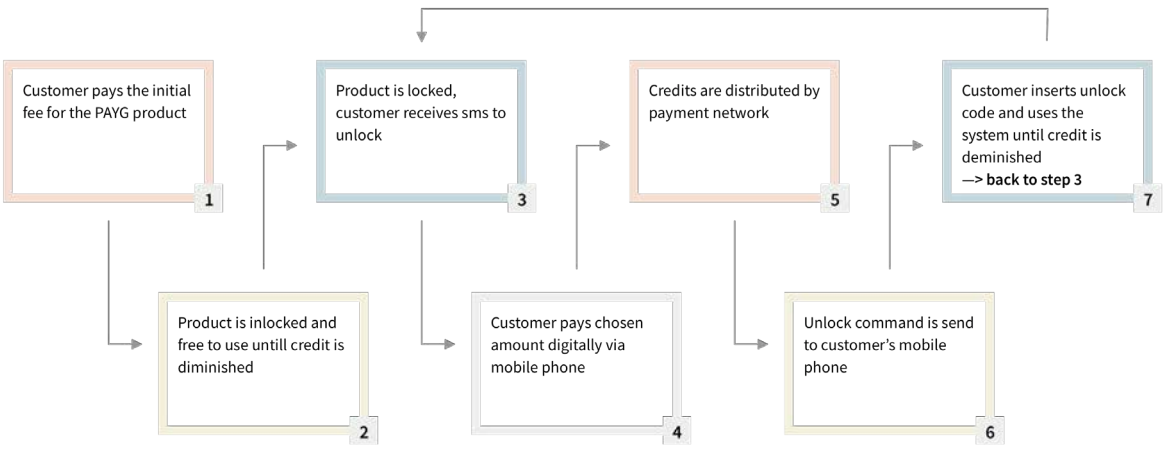


FIGURE 13: **PAYG SYSTEM JOURNEY**

For the distributor, this means that PAYG offers them the ability to sell more expensive products to people and thus generate more revenue from a relationship with a customer. International Finance Corporation calculated that during an eight-year customer journey differences in revenue caused by different payment methods could be substantial, as could be seen in Table 4.

Payment method	Potential revenue from client
Cash	€332
PAYG only	€1005
Combination of cash and PAYG	€475

TABLE 4: **POTENTIAL REVENUE PER CLIENT PER PAYMENT MODEL**

Another benefit of using PAYG services is that PUE products come within range of a larger group of potential customers. PUE products help to increase wealth by making people more productive. For example a solar powered water pump for a farmer increases the farmers production efficiency and thus provides for a stronger financial position. This way PAYG can reduce poverty (see Figure 14).

ALTERNATIVES TO PAYG

There are several alternatives to PAYG active in SSA. In some regions, people have the ability to apply for a micro credit, this is a small loan provided to people without access to formal banking services. Most of the micro credit systems provide loans in kind. For example, a farmer receives an amount of seeds and has to return that amount by the end of the season. What is left can be kept for himself.
The aim of micro-credit institutions is to stimulate people to start small business and empowering people by showing that they are able to run one (Ahlin & Jiang, 2008). Hoping that one thing leads to another and small businesses become larger over time.

Next to micro credit, group savings are another way to help people finance bigger purchases. When saving in a rotating group, a group of people meets regularly and brings a predefined amount of money to every group meeting. During this meeting, the group decides which one of the members is allowed to borrow money from the group this week. When saving in a non-rotating saving group, savings are accumulated rather than distributed with each collection, this in turn providing insurance against the unexpected financial costs of daily life situations faced by members of the group (Aryeetey, 1997).

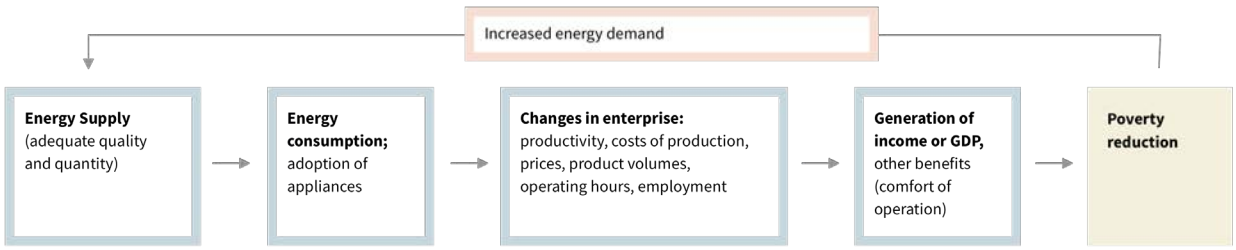


FIGURE 14: **STEPS FROM PUE TO POVERTY REDUCTION - ADOPTED FROM KOOIMAN - VAN DIJK (2008)**

Homie Pay Per Use

Homie started as an experiment by TU Delft Associate Professor Nancy Bocken with two business partners. The company offers to place a washing machine in a house which for which the user pays per time using the machine (pay-per-use). Because a cold wash is cheaper than a hot one, people are nudged to consume less energy while washing.

Sunny Irrigation

“Solar Power Irrigation for East Africa” - This company sells waterpumps on a rent-to-own base to farmers. The pumps are sold with a contract for eighteen months of steady payments and offer farmers the possibility to use PUE for poverty reduction.

MyJouleBox

The French start-up MyJouleBox developed a technical solution to control SHS on a PAYGO base. Their product fits between the battery and the other products and controls the PAYG payments and operation of the SHS.

FIGURE 15: **EXAMPLES OF PAYG PRODUCTS**

Product-Service-Systems

A Product-Service-System is a combination of product(s) and services sold together. A PSS should offer more benefits to the customer than when both are sold separately. With a growing trend of servitization, the economy tends to be more service oriented and PSS fit in well. This subchapter elaborates on what a PSS can mean for the market introduction of the MTego.

WHAT IS A PSS?

A PSS can be defined as "a marketable set of products and services capable of jointly fulfilling a user's needs. The product/service ratio in this set can vary, either in terms of function fulfilment or economic value" (Goedkoop, van Halen, te Riele, & Rommens, 1999). To provide an example, the printers of Xerox were previously sold as a one time purchase. This was a big investment for a company that needed to be spread over several years. The printers also needed to be maintained, for which the company would get a maintenance contract, charged per visit. With a PSS, the customer pays for the amount of prints that are made, and Xerox provides printers, ink, and maintenance. The benefit for the user is the certainty that the printer is working and up-to-date at all times, together with a fixed fee per copy – generally paid in monthly instances. The benefit for the supplier is that they create a long term relationship with their customers and are able to take care of their own products. See Table 5 for more examples.

With the help of PSSs, ownership models can and will change. Where it was normal to buy a product that one needed for only one occasion or for a certain amount of time, it is now possible to rent this product for the time needed. The product can be used by multiple customers instead of it ending up disused and in permanent storage.

Figure 16 shows the three types of PSSs that can be differentiated (Tukker & Tischner, 2004). These are:

- **Product oriented PSS:** the customer owns the product that is sold together with supporting services. The services are aimed at adding value to the product life cycle.
- **Use oriented PSS:** the supplier owns the product that is sold together with the supporting services. Enabling platforms for customers are offered.
- **Result oriented PSS:** the supplier offers a solution for the customers need, the customer pays for a working solution. The customer buys a final result.

For the MTego, a PSS from the first category (product oriented) should be developed because this is the most product related type of PSS. The market is not ready for product lease systems that are more use or result oriented yet (Africalease, 2018).

Company	Type of product	PSS description
Xerox	Office equipment	Pay-per-copy models for office buildings
Atlas Copco	Air compressors	Rental services of compressed air per m3
Michelin	Truck tires	Management of tyres of a transportation company per kilometer driven
Philips Lighting	Lighting systems	Selling a level of illuminance, on a pay-per-lux base
Swapfiets	Urban bicycles	Transport for a monthly fee
Gerrard Street	Headphones	Headphones as a service
Boldking	Shaving equipment	Auto restock shaving blades

TABLE 5: **LIST OF PSS EXAMPLES - VAN OSTAEYEN (2014)**

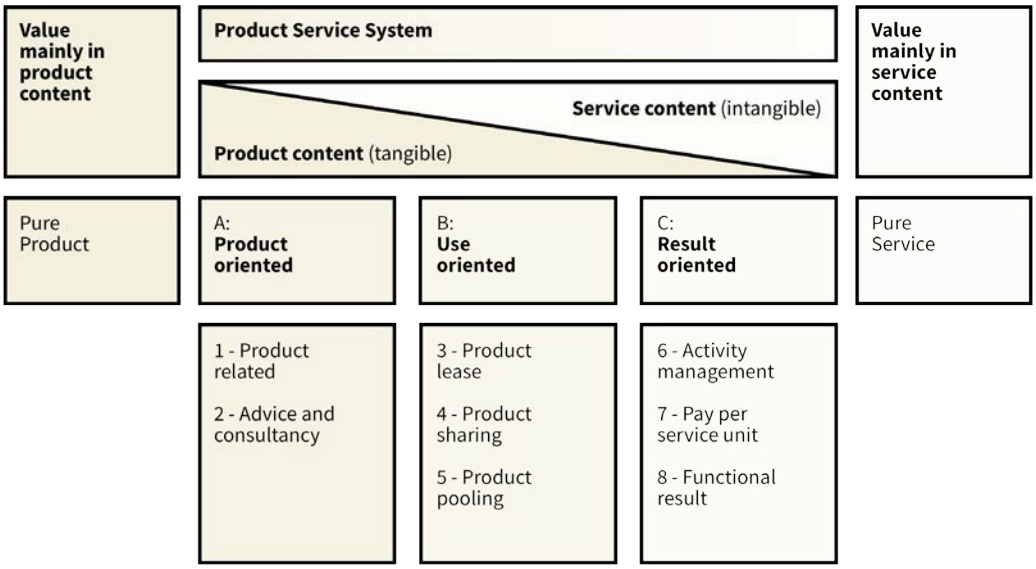


FIGURE 16: **THREE TYPES OF PSS - TUKKER & TISCHNER (2006)**

BENEFITS OF USING PSS

Diehl & Christiaans (2015) highlight four benefits for other stakeholders than the producer from moving from products to product service systems:

- **Customers:** Providing value through more customization and higher quality. The service component, being flexible, can also deliver new functionalities better suited to customer needs.
- **Manufacturers:** Realizing the limits of mass production and cost reduction. Now competing on the basis of value delivered rather than on basis of costs. In addition products are relatively easy to imitate by competitors, whereas PSSs are less easy to replicate. PSSs offer also closer and longer relationships with the customer and consequently better understanding of them as well longer (and more) financial transactions.
- **Governments:** Replacing loosing jobs in the manufacturing sector (often going abroad) by new jobs in PSSs (especially the service element which is labour and relationship intensive).
- **Society:** By increased sustainability:
  - Compared to the traditional product sales model, within a S.PSS model a company can improve revenues if it can meet the same demand by providing a less resource-intensive product and related service mix.
  - During the use phase, the producer has potential economic interest to reduce the amount of resources consumed, because profit is dependent on the cost per unit of service provided to the customer.
  - Since the provider remains the 'owner', or at least retains some responsibility for the product over its life cycle, there is an economic incentive to extend the product's lifetime.

For the MTego PSS, the customer benefits are similar and the higher product quality is desired. The manufacturing company benefits from the PSS both because the value of the product becomes the competing element instead of costs and because PSS are less easy to replicate for competitors. The governmental benefits are different in Malawi and Mozambique as jobs are not replaced but created. Introducing a PSS creates jobs for people due to its labour intensive service element. Although different, this still is a benefit. The increased sustainability component does not fully apply for the MTego project as the MTego will be offered as a 'product oriented PSS' on a 'rent-to-own' base. This means that the customer becomes the owner after the contract period and for every customer, at least one MTego is needed.

Key take-aways

SHS MARKET

A Solar Home System is a system that combines a solar cell, a battery and a charge controller together with add-on products like light bulbs, a radio and a TV. These systems provide in the **basic energy needs** of people living in rural areas throughout the world. SHS can be divided in categories ranging from pico systems for a torch to mini-grids that can provide large rural hospitals in their needs. The impact that these systems make globally is substantial due to the **multiple benefits** that they bring to people and the ecosystem. A SHS provides for **financial savings** on energy costs like kerosene, for **health improvement** by reducing respiratory and eye issues and reducing burns and accidents, **reduction of greenhouse gas emission** and it can support **income generating activities.** The potential market for SHS grew to 434 million between 2010 and 2017. This market is **expected to grow** even further due to both economies that are emerging and a continuously growing population.

BASE OF PYRAMID CUSTOMER

People living at the Base of Pyramid have very little disposable income and **experience barriers to clean energy and healthcare**. Many BoP households do have a mobile phone. People in SSA are getting **used to mobile money** fast as in some countries the use of these services exceeds formal banking services. The average person in Malawi is to be considered **extremely poor** and has less than 1$ per day to live off. The countries most important economic driver is their agriculture sector, as it is responsible for 80% of the GDP.
Base of Pyramid customers are oftentimes **energy poor**, this means that they do not have access to clean sources of energy. Being energy poor reduces people's health and wellbeing. **Malaria is a recurring problem** amongst this group of people as many BoP people are living in malaria zones throughout the world. BoP people do not have sufficient malaria prevention techniques available, nor do they have **knowledge or financial means** at hand. In 2017, about 435000 people died from malaria of which 61% are children under 5 years old.

ABOUT SOLARWORKS!

SolarWorks **distributes SHS and add-on products** in Mozambique and Malawi and has their distribution headquarters in Johannesburg, South-Africa. The company currently **offers three product packages** and is exploring other products to add to their portfolio. Some products that could potentially be added are a sewing machine, refrigerator, freezer, and a water pump. The company **employs their own sales agents, installers and managers** providing for the ability to operate in rural SSA countries.

PAY-AS-YOU-GO PAYMENT MODEL

PAYG is a **prepaid payment model** developed to make previously unaffordable products or services available to a broader public. It is a way to provide people with loans they otherwise would not be able to acquire. P**AYG products are used as a collateral** for the loan. For the MTego, the proposed PAYG model will be **rent-to-own** where the user pays per period and acquires ownership after the contract period. There are **benefits** from this model for both the buyer and the seller; the buyer is able to **buy better systems** that increase family health and wellbeing, while the seller has the ability to **generate more revenue** from its buyers by selling more expensive systems. The alternatives to PAYG rent-to-own are group saving and micro credit which both have their advantages and disadvantages, however PAYG suits the introduction of the MTego best.

PRODUCT-SERVICE-SYSTEMS

A PSS is a combination of products and services sold as a package, **combining both** to increase customer experience. PSS change ownership models due to offering the ability to rent a product for the time needed. For the MTego a **product oriented PSS** is advised where the customer owns the product and receives complementing services adding value to the product life cycle. PSS come with **benefits for the customers, the manufacturers, the distributors, governments, and society** due to increased sustainability.

3. Field Work

A field work trip to Malawi was made to gain a deeper understanding of the customer by researching their way of living and uncovering their needs and wishes. Next to the customer, SolarWorks! has also been observed. This chapter elaborates on the methods used, followed by the generated results, and ends with an analysis of results.

This chapter highlights the relevant findings from the field work trip and includes an analysis of these findings. It starts with an introduction about the location were the field work was executed, to be followed by the methods that were used and the achieved results. For other observations made during the field work, see Appendix A on page 80.

FIELD WORK TRIP

PreMal organised a field work trip to Malawi to investigate the effectiveness and technical qualities of the MTego mosquito trap during a month-long field trial. In this trial, six participants were selected from the customer base of SW. At the houses of these participants, indoor traps were placed to measure a baseline of captures without intervention for seven days. After this first week, either a Suna Trap or a MTego trap was placed outside of the houses and differences in indoor captures were compared. Next to this, technical qualities of the trap were researched by placing it in the field, and the perception and value of the product was also noted. During this trip, I was offered the ability to focus on the customer and business side of the introduction of the MTego trap to Premal's target customer. For this I planned and performed my research individually, and I had daily access to this group of six trial participants.

LOCATION

The map in Figure 17 shows Malawi with a close-up of the Dowa district where Mponela is located. Mponela is the town where most of the research has been conducted. The town has a 'trade centre' with a daily market, some shops and restaurants. Most of the people do not live in this trade centre, but just outside of it, in the small villages that are connected to Mponela.
Positioned centrally along the M1, SolarWorks opened their shop in a building that they share with Farmers World Malawi, an centralized that sells products for farmers, like centralize and crop protection.

HOUSES

Figure 18 & Figure 19 on page 40 show two houses of study participants. These brick houses with corrugated iron roof are owned by the more wealthy people of the community. These people are either farmer with their own land or school teachers. With regards to the farmers, most of the other village inhabitants work for them and some live on their land.

Notes about these houses are that the house in Figure 18, is the most luxurious field house that has been visited. This house had both a grid connection and a SHS with TV, but also running water and a water closet toilet. On top of these luxurious features, the house had three bedrooms, a kitchen room, a bathroom and a toilet. It was a specious house for the three inhabitants.

The house in Figure 19 had two SHS installed, one from SW and one other system that was bought on the market. This second system was used as a backup system and did not work as good as the one from SW. This was the house of a farmer that had four families living on his land that also worked for him. The smaller building on the right side of it was used for cooking with charcoal stoves. It was interesting to see that most houses did not have open eaves or windows. The houses could be closed at night to decrease chances of mosquito entry.

FIGURE 17: **MAP OF MALAWI BY UN**

FIGURE 18: **HOUSE 1 OF STUDY PARTICIPANT**

FIGURE 19: **HOUSE 2 OF STUDY PARTICIPANT**

Research method

CUSTOMER QUESTIONNAIRE

A questionnaire was developed to collect data from a broad range of potential SHS customers. This questionnaire was presented to different people during the field project. Participants included SW employees, our field driver, solar home users, potential SW clients, SW office visitors, hotel employees, and other people met in public spaces. This questionnaire can be found in Appendix B on page 82. The questions asked were to be divided in three categories being:

- Participant demographic
- Finances and expenditure
- Mosquito problem

INTERVIEWS

Interviews with trial participants were conducted. The group of trial participants consisted of six households that all participated in the MTego technical field trial conducted by PreMal. These people received three interview sessions during the trial period, starting with the customer questionnaire, to be followed up by two semi-structured conversations. During these conversations, following topics were discussed:

- What kind of pricing plan would you prefer?
- What do you think about the traps provided so far?
- Would you be willing to buy a trap at MWK 120.000 (€150)?
- Storing odour sachets at home or picking them up in store?
- Upgrade priority, would people rather buy a TV or a MTego?

For these interviews, two conversation starters were developed. The first of which was a game that was designed to uncover the upgrade priorities of people, called ‘upgrade priority game’ (see Appendix C on page 85). The second piece was called a ‘pricing prototype’ (see Appendix D on page 86) to spark the conversation about the possible ways of paying for the product.

CALL CENTRE

Two call centre visits were made during the field-study with two different goals. During the first visit, a call centre agent was joined while she called new customers that had a SHS installed 25 days ago - a 25-day call session. The purpose of these calls was to monitor customer satisfaction, rectify any issues and encourage the customer to pay for the next monthly instalment. The research goal of this day was to get a picture of how SW customers react upon their first remote contact and which questions they formulate towards the agent.

During the second call centre day, a promotion strategy for the MTego was tested. The first 20 customers of SW Malawi that were able to keep up with their payments were called, but only 12 of them could be reached. Of these customers, 7 had a TV with their solar system and 5 had not. During each phone call, the call centre agent introduced the MTego mosquito trap and provided a brief explanation. They then asked the customer if they wanted to know more about the product and if it is something they would be interested to buy.

SALES TEAM

Two sales teams of SW have been joined on a day in the field. During the first day, a sales team in Ntchisi, a village 15km east of Mponela was observed. The sales agents set up the sales tent in the village to display their products and services to local villagers. The MTego was not brought to this session on purpose. Sales agents were observed both during door-to-door promotion and sales around the village and during conversations at the sales tent. Information about conversations between agents and villagers was noted to broaden the picture of the potential customer.

On the second day of joining the sales team, the team at the Mponela shop was joined for four hours. The MTego was presented next to the products of SW as if it was available for sale. The agents were asked to try and sell the product to evoke a reaction of potential customers. For this, basic technical specifications and a flyer with a price plan were provided to the sales agent. In Figure 20 on page 42 an example of this flyer is shown. Observations, comments and interest to purchase were noted together with the questions that potential customers had about the product.

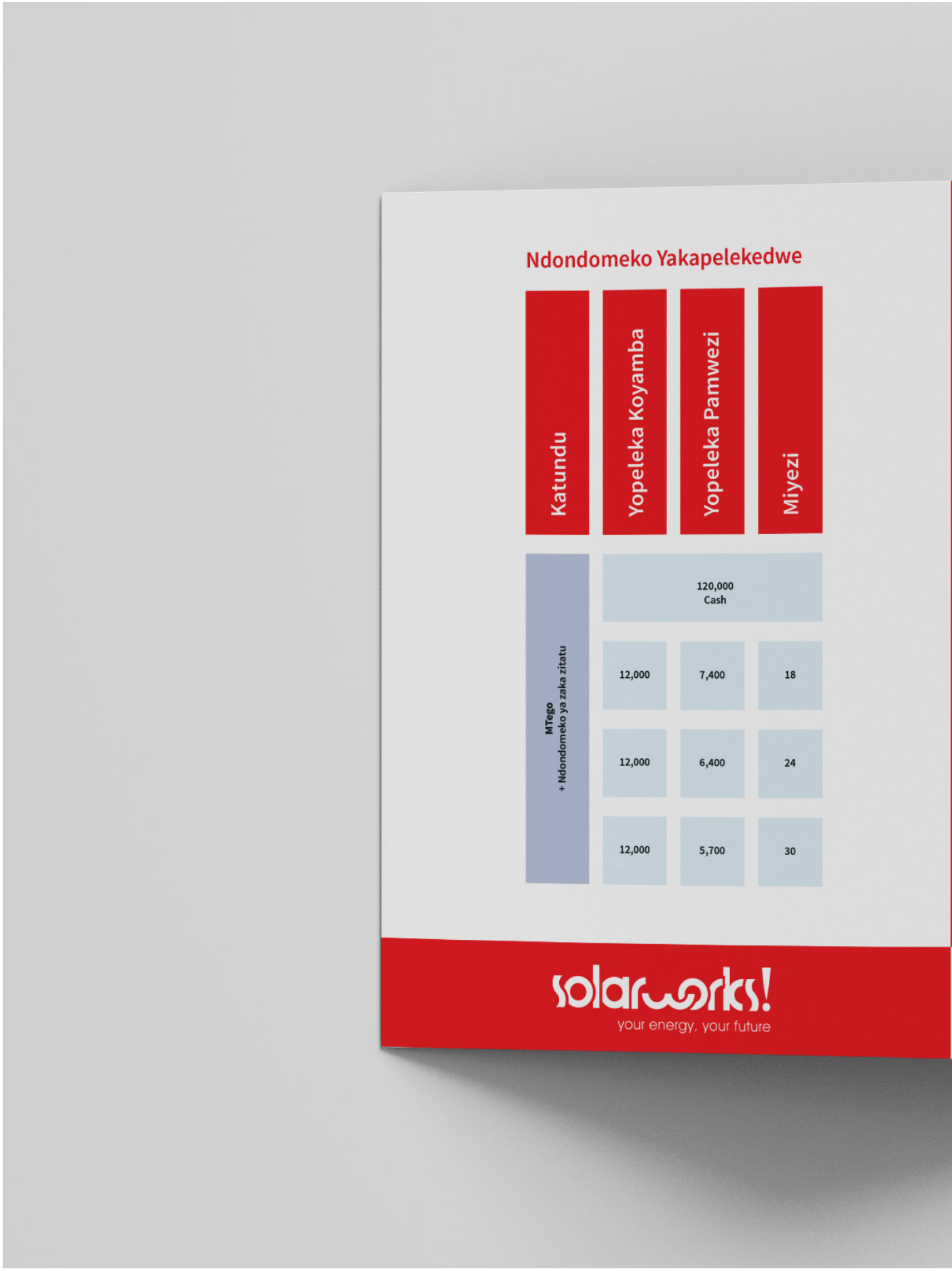


FIGURE 20: **MOCK-UP FLYER MTEGO**


Kuthana *ndi udzudzu* ndi
MTego Mosquito Trap!
MTEGO
MOSQUITO CONTROL
solarworks!
your energy, your future

Research results

CUSTOMER QUESTIONNAIRE

The customer questionnaire was divided in three sets of questions that were answered by 29 participants. Not all of the responses were 100% complete because some people did not want to or were not able to answer all of the questions, so for some questions there were less then 29 answers. See Appendix E on page 87 for the full dataset, for graphs of the results see Appendix F on page 89.

PARTICIPANT DEMOGRAPHIC

To get a broad overview off the people that participated, demographical questions were asked. The people that participated in this questionnaire lived in both the Lilongwe and Dowa districts of Malawi. The mean average family size was 4,4 with answers ranging from 1 (n=1) to 7 (n=3). In Malawi, the average household size is 4,5 (United Nations, 2017 & National Statistical Office, 2016). This answer reflected the population of the country accurately. All of the participants had a job, of which most of them were farmer (n=7), sales agent (n=5), and hotel worker (n=4). Other jobs that were noted were photographer, driver, primary school teacher and credit controller.

FINANCES AND EXPENDITURE

Families monthly food spending answers ranged widely from MWK 10.000 (€12,50) to MWK 195.000 (€245) with a mean average of MWK 75.625 (€95). This could have several explanations, one of them is that the family size differs from 1 to 7 and thus the amount of people to feed differs accordingly. Also, reported expenses differ due to the fact that they differ month over month. Considering an average GDP per capita of 401 USD in 2018 (The World Bank, 2018), a family of 4,5 should have an average yearly budget of 1804 USD or 1620 EUR. In a study about what BoP customers spend their money on, it was found that people spend more than half of their budget (58%) on food (Subrahmanyan & Tomas Gomez Arias, 2008). In the case of the average family in Malawi, this would be around €940 per year, which would result in €78 per month, fairly close to the €95 that has been found using the questionnaire.

School fees (n=20) ranged from MWK 1.000 (€1,25) to MWK 150.000 (€187,50) with a mean average of MWK 32.200 (€40,40). Although public hospitals in Malawi are free, the mean average (n=28) monthly healthcare spending was MWK 13.414 (€16,80) with a minimum of MWK 1.600 (€2,00) and a maximum of MWK 80.000 (€100,00). This money mainly goes to related expenditures being: travel costs to the hospital, medicine at small shops, and birth control. About half of the money spend on health expenditures goes to malaria related healthcare. From the 24 answers, these spending ranged from MWK 300 (€0,40) to MWK 30.000 (€40,00) with a mean average of MWK 7.367 (€9,25). For an overview of these numbers see Table 6.

	Food *(MWK)*	**School fees** *(MWK)*	**Healthcare** *(MWK)*	**Malaria** *(MWK)*
Lowest spending	10.000	1.000	1.600	300
Highest spending	195.000	150.000	80.000	30.000
Mean spending	75.625	32.200	13.414	7.367

TABLE 6: MONTHLY EXPENDITURES BY QUESTIONNAIRE PARTICIPANTS

MOSQUITO PROBLEM

Almost all of the participants mentioned that mosquitos can cause malaria and that malaria is bad for both the health and economic situation of a family. These people explained they learned about this topic in school. One of the six participants of the technical trial in Mponela showed knowledge about mosquito species and that the female anopheles mosquitos are the one spreading the parasites. Only one out of 29 respondents (3,5%) said he did not have a problem with mosquitos. The other 28 rated the question: “How severe is the mosquito nuisance that you experience with your family?” With an average of 4 on a Likert scale of 1 to 5. One fifth of the respondents (6 out of 29) said not to be using a mosquito net, while the resulting 80% did. During this study, it has been found that if people do not use one, it is either because they do not believe that they need it, or they did not want to spend money on preventive measures. The next most common malaria prevention techniques mentioned are mosquito repellent spray (31%), coil (21%), and doom (14%). Most people use a combination of techniques mentioning that the mosquito net only works when sleeping.

Participant	Trap positive	Trap negative	Preferred trap	Willing to pay	Sachet pick up	Upgrade
1	Works well		Indoor	Maybe	Pick up from shop	TV
2	Works well	Too much power	Indoor	yes	Pick up from shop	Trap
3	Less mosquitoes	Too much power	Outdoor	yes	Pick up from shop	Trap
4	Works perfectly	Too much power	Indoor	yes	Pick up from shop	Trap

TABLE 7: INTERVIEW RESPONSES TRIAL PARTICIPANTS

Skarbinski, Mwandama, Luka, Jafali, Wolkon, Townes & Mathanga (2011) researched amongst 29.806 individuals in Malawi and found that 58% uses a mosquito net for the correct purpose. While Berthe, Harvey, Lynch, Koenker, Jumbe, Kaunda-Khangamwa & Mathanga (2019) performed a study in Malawi, they found that misuse of mosquito nets is still a problem in the country. Most prominent reasons for misusing nets are poverty and food scarcity. While they asked their participants what the correct use of a mosquito net is, almost all of them stated that sleeping under the net was the only correct use. Despite this understanding of correct use, most of the participants also acknowledged that misuse of the nets was very common.

One out of 29 respondents said not to be interested in a new malaria prevention technique. The resulting 96,5% said to be willing to try a new malaria prevention technique. The reasons why people want to try a new technique vary from: “bednets only work when you’re in bed” to “lower suffering from malaria, health boost for the family, saves money on spray, live long” to “it is hard to find money for treatment”.

INTERVIEWS

Four out of six participants that joined the technical trial by PreMal were available for two semi-structured interviews. The key points of these conversations were extracted into six categories. Following six points were distilled from the answers:

1. Positive feedback about the traps
2. Negative feedback about the traps
3. Which trap was preferred: indoor or outdoor
4. Willingness to pay 120,000 MWK for the MTego mosquito trap
5. PM6 odour sachets are preferred all at once or pick-up when needed
6. Upgrade priority: the trap or TV

From Table 7, the negative feedback about the trap was a recurring topic amongst trial participants. People explained that the trap stopped working halfway through the night, only to turn on again when the sun started shining in the morning. People added that they were not willing to turn the TV off to let the trap run longer. A strong preference for the indoor trap was also noted. This preference could partly be explained by the reason that the indoor trap had a source of energy separated from the participants SHS. A unanimous preference for picking the sachets up in the SW store every month was also noted. Reasons that people gave for preferring to pick-up the sachets themselves were that they would not know how to keep them save from children playing, pests and weather influences. Only 25% (n=1) said to rather have a TV than a mosquito trap, the resulting participants preferred to have a trap that potentially protects their family from malaria infections. While asking this question, price was not taken into account and the MTego and a TV were presented as being mutually exclusive.

CALL CENTRE

At their headquarters in Lilongwe, SW has a call centre with on average six employees providing support to their 1200 customers country-wide. One agent working in this call centre was joined on two different occasions to get a picture of how the interaction between agent and customer went on the phone, and later-on to trial promoting the MTego over the phone.

EXPLORATIVE CALL CENTRE SESSION

During the first day at the call centre, the agent was calling people that had the system installed 25 days ago. During this call, the agents aim was to solve any problems that new clients had and encouraged people to pay for the next month. Six calls were made during the observation period, of which 5 outgoing and 1 incoming. The incoming call was from a customer that did not receive his monthly upgrade code after paying for one.

FIGURE 21: **SW SALES TEAM IN NTCHISI**

The problems that came to front during these calls were:

- PAYG code not working
- Not enough money to pay for the upcoming month
- Radio was not working properly

Of the five outgoing calls, one customer could not be reached. Of the four people that could be reached, two did not experience any problems, were happy with the system, and already paid for the next month. Of the other two customers, one did not receive his code yet, while the other was unable to pay for the next month. The client with a radio that did not work as expected, was send to the nearest SW shop to have it checked and replaced if necessary.

CALL CENTRE SALES TRIAL SESSION

A second visit to the call centre was made to test a sales and promotion strategy on the phone. The aim was to find out how people reacted to the MTego when a sales agent would sell it to them on the phone. The people that were selected for this trial had their systems installed between June 2019 and August 2019, which means that they had not paid them off completely, but that they were able to pay the instalments in time.

The agent was asked to explain the MTego to the client and ask if he would be interested to know more about it. Most people wanted to know the price of the product and all of them understood the concept of a mosquito trap. Four out of 12 showed intertest in the trap, of which one said to discuss the purchase at home and call back within an hour. One client had a problem with his current SHS system, which had to be solved before further discussing a new product, other reasons were that the purchase needed to be discussed with spouse (n=1) and that the current payment plan needed to be finished first (n=1). No sales were made during this session.

SALES TEAM

SW sends sales teams to villages surrounding their offices to promote and sell their products. The teams set-up a red company branded tent in the middle of the village (see Figure 21) and display the available products. On two occasions these teams were joined with different goals in mind.

EXPLORATIVE SALES SESSION

The aim of the first day with this team was to acquire an overview of how SW's regular sales process works and how the potential customers respond to the promotion activities of the company. During this day both agents that stayed stationary at the tent and agents that did door-to-door sales were followed. The sales agents conducting door-to-door promotions selected houses of a build type and quality representative of their target market to have a conversation with the owner of the house. This conversation provides the agent with the opportunity to market products and services whilst addressing any questions presented by the potential customer. Usually the agents do not make sales while on these promotion walks through villages, but they market SW products and gather phone numbers of potential clients.

FIGURE 22: **TRADE CENTRE SHOP TRIAL 1**

FIGURE 23: **TRADE CENTRE SHOP TRIAL 2**

The most frequent questions that potential customers asked were:

- How does warranty work? Do we get new products or will the system be repaired?
- What happens if we do or can not pay for the loan?
- What is the longevity of the systems?
- How many hours of light provide the systems and how do they compare to each other?
- How to pay for the service?
- How to stay in contact with the agents?

All of these questions could easily be answered by the sales agents because they were prepared for them and answered them before.

Only one family out of six was not interested in purchasing a solar system and stated not being able to afford it. None of the remaining residents was willing to make a purchase at the time, although interested to do so. Of these, 2 families said that they would have money for a SHS when their crops were harvested. All 5 of these residents exchanged phone numbers with the sales agents which will later-on be used to follow-up.
Furthermore it was observed that people seemed to understand how the products of SW work, most of them do not need a demo of the products before asking about pricing and payment options. It was found that husbands are the ones to decide on big purchases, but the wife also has her say in the process. Per hour, about 25 people visited the tent, these were mainly men doing business or joining social activities in the trade centre.

TRADE CENTRE SHOP SALES TRIAL

The second day with the sales team was planned as a sales trial to see how potential customers would respond to SW offering the MTego at the trade centre office of SW in Mponela. The MTego was brought to the sales tent and presented as if it was one of the products for sale (see Figure 22 & Figure 23). During this afternoon, 12 customers were engaged in conversations regarding the MTego. The sales agent was able to explain the function and specifications of the trap to interested customers. The agent was provided with a flyer with information and pricing plans of the MTego for them to discuss with potential customers.
Out of 12 conversations, 6 (50%) showed interest to buy the product, however no sale was made during this day due to various reasons of which the most common one was that the potential customer was not able to spend the money at this point in time. Other reasons were that the costs of the product was too high (n=2), that the purchase must be discussed with other family members (n=1), and that the current PAYG-loan must be paid-off before taking a new one (n=1). Of the two people that highlighted the high cost of the product, one suggested that he could afford an overall cost of 70.000-80.000 MWK (€86.46 - €98.81).

Analysis of results

IS THE MARKET READY FOR THE MTEGO MOSQUITO TRAP?

It was found that the awareness about mosquitos and preventive measurements amongst the target group was fairly high. People are aware of the fact that they should be extra careful with mosquitos around young children, and showed efforts to reduce chances of getting infected with malaria. It is thus not a surprise that participants rate the mosquito problem quite sever, ranked on average 4 on a Likert scale of 1-5. This finding is supported by the fact that 90% of people questioned use at least one method of mosquito control and that only one out of 29 said not to be interested to try a new preventive method.

With a free public healthcare system in Malawi, people still spend on healthcare related expenses like travel costs, medicine and birth control. About half of this money (€9,25 monthly average) is said to be allocated for malaria related healthcare, which could include mosquito control methods and medicine. People link the potential purchase of the MTego to future savings on both time – by not having to visit the hospital - and money - for malaria related healthcare expenses. If the MTego, with its potential costs savings for this category, would be available for less than €9,25/ month, chances are that people are willing to reallocate their spending towards this product.

With regards to the upgrade priorities of people, it has been found that about half of the people said to prioritise the mosquito trap over a TV. One man can be quoted: “I cannot watch TV when I’m sick of malaria, right?”. The field work phase showed that the market is ready for the introduction of the MTego mosquito trap as an add-on product to the SHS market.

WOULD THE TARGET GROUP BUY THE PRODUCT?

The target group earns by estimation between €250-€400 per month, which is above average for rural Malawi. Other findings were that most farmers pay for the upcoming year when they harvested their crops, this generally happens between May and June in Malawi. SolarWorks provides for this option because it gives them more security that their customers will be able to pay off their loan in the long run. A price of €150 (MWK 120.000) would be on the high side of the spectrum for the MTego with 24 months of service, but participants were willing to buy the trap at this price point. From this finding it can be concluded that if it would be possible to lower the price, the target group for the product enlarges.

A major drawback for people to buy the MTego was that they would not take on a new loan before they paid off their present one. This barrier was in place during door-to-door sales, when asked current clients face-to-face, and on the phone. This is finding should be taken into account when deciding on which people to target and when. It did seem however, that people would be willing to take a new loan after they did pay off their current one, which opens an opportunity to sell the product.

Most people preferred the contract with the lowest monthly costs; the longest contract offered. One reason for preferring this could be that this contract is the most risk averse one; by minimising the monthly commitment, the chance of being able to pay it becomes bigger. Most people were aware of the fact that they would pay more for this contract in the long run, but said not to be able to afford shorter payment plans. It should be noted that most people (7/29) were farmers that had irregular income, of which most of it was generated between May and June when their crops were harvested and sold. It can be concluded that the affordability of the trap is currently questionable.

HOW TO TRIGGER PEOPLE TO PURCHASE THE MTEGO?

The agents that performed door-to-door sales received full attention of the homeowners. People passing by the sales tent in the trade centre took time to listen to the agents and ask questions about the products on offer. The MTego attracted people's attention to the tent and it was an effective conversation starter as this innovative product intrigued passers-by. Flyers were effective as people are not used to receiving a high-quality print item and take it home to talk about it with their families. Thus, it can be concluded that conservative promotion techniques work well and that people are not ready yet for more advanced methods of promotion like TV commercials, social media strategies, and WhatsApp promotion.

Since people do not often make a purchase this big, they prefer to see the product, and think twice before they decide on buying it. It is important for people to be able to get back to the company whenever they feel like making the deal. The CRM system of SW helps to keep track of potential clients and provides the company with the ability to give a follow-up call to convert a potential customer into a customer. According to SW's Operation Director this is the most effective and efficient way of having contact with their client base. However, it has not been validated whether sales could be made on the phone. SW's CRM system also offers the ability to select customers that are potentially ready to upgrade and advertise their products directly targeted at them.

While directly calling customers, only two out of twelve stated that the product was too expensive, the resulting ten were interested to hear what was on offer and which payment plans were available. Although 10 out of 12 customers showed intertest, the financial ability to make the purchase lacked with most of them, while the resulting group was unwilling to commit to a new payment plan while currently committed to one.

People highlighted to feel protected by the traps, which can be a USP when developing promotion materials for the MTego. It was also observed that amongst the six trial participants, some preferred the inside trap over the outside trap. The main reason given was that the inside trap was less prone to outside influences like weather and thieves.


solarworks!
your energy, your future

4. MTego PSS Design

The Product-Service-System consists of six elements that cover the process of getting the MTego from the production facility to the customer. These elements each consist of considerate decisions that include arguments based on field-work findings, stakeholder arguments, other sources, and assumptions.

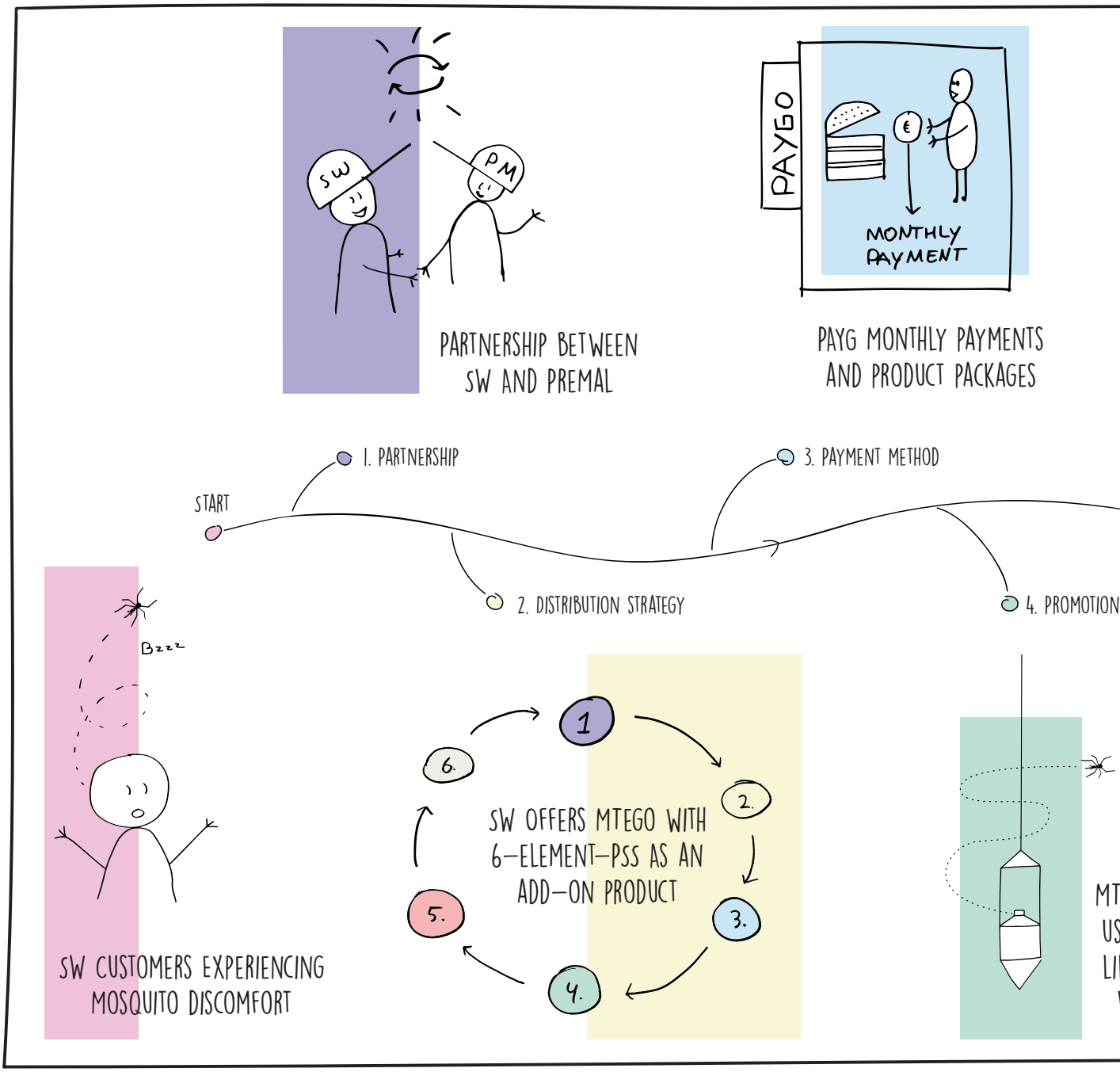


FIGURE 24: **MTEGO JOURNEY ILLUSTRATION**

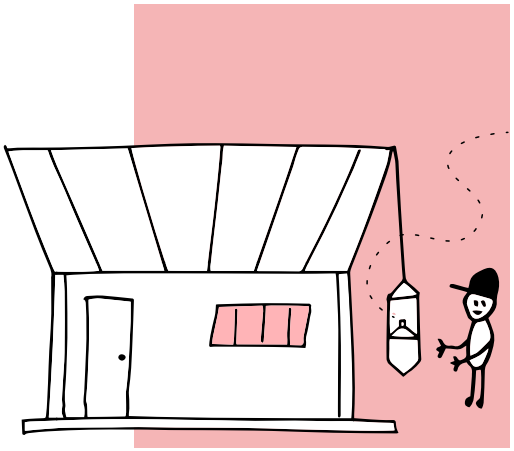
MTEGO JOURNEY

Figure 24 illustrates how the partnership between SW and PreMal is designed for satisfied customers experiencing better health and less mosquito discomfort. The illustration also articulates that in the MTego PSS, promoting, selling and maintaining the mosquito trap is SW's responsibility. The decisions that have been made in the process of designing the MTego PSS have been divided into six elements and will be elaborated upon in the following pages.

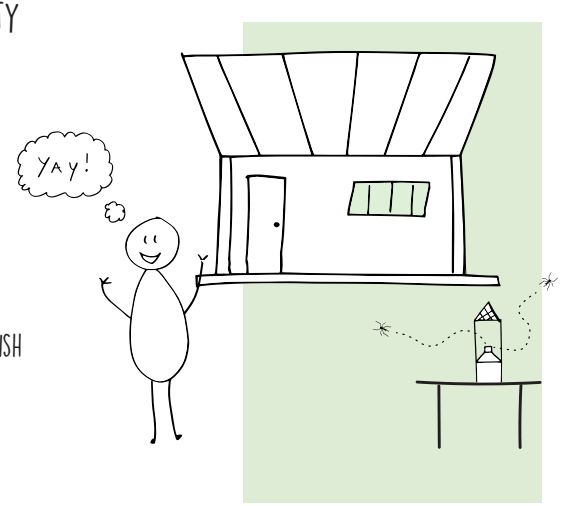
The PSS elements are:

1. Partnership
2. Distribution strategy
3. Payment method
4. Promotion plan
5. Warranty and repairs
6. Shipping and financing

MTEGO JOURNEY



SW AGENTS MAINTAIN AND REPAIR MTEGO. 2 YEARS OF WARRANTY

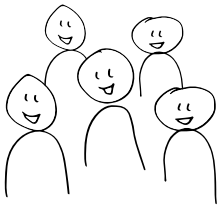


5. WARRANTY AND REPAIRS

FINISH

PLAN

6. SHIPPING AND FINANCING



TEGO PROMOTED AND SOLD
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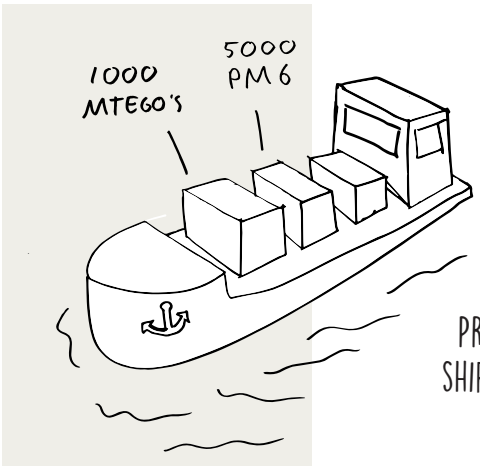


PRODUCTS ARE SHIPPED FOB SHIPPING POINT WITH RELAXED PAYMENT TERMS

HEALTHY CUSTOMERS EXPERIENCING LESS MOSQUITO DISCOMFORT

Partnership

Partnering-up with SolarWorks!
PreMal is a startup with currently only two employees; the two founders Fairbairn and Fiori. PreMal does not have the resources to build it's own network of agents and distribution channels in SSA because PreMal does not have the financial means and it is expected not to be economically feasible to set this up only to distribute one product. Therefore, the decision was made to partner-up with SW and make use of their infrastructure for marketing, sales, distribution and maintenance.
PreMal needs to target people that have a stable electrical energy supply. A SHS provider electrifies people in rural areas. Thus, a SHS provider could offer PreMal access to their target group.
PreMal and SW are connected to each-other because both are Dutch companies started at the same university. SW was also chosen as the first distributor to partner-up with because of SW's size and maturity in the SHS market. SW is a medium sized company compared to M-KOPA. If PreMal succesfully implements this plan with SW, it could prove succes to bigger SHS distributors and open opportunities for collaboration.

The business model in Figure 25 on page 56 shows how streams of goods and revenue would run through SW, PreMal, and other suppliers to the customers. In this figure, SW acquires products from both PreMal and other suppliers and combines them into packages that are then sold as 'Solar Home Systems'. These products include bulbs, radios, TVs, torches, and MTego's. SW sells products to customers directly with internal sales agents, but also uses independent external sales agents that sell their products to customers.

Introduce the MTego in Mozambique first.
The decision of which market to introduce the MTego followed directly from the partnership between PreMal and SW. SW operates in Mozambique and Malawi because both markets were not saturated yet with other SHS providers, like the further developed countries Kenya, Tanzania and South-Africa. This provided SW with the ability to become market leader before competitors entered the market. In this market it is beneficial to hold a high market share in an area because of the costs per area.
Of these two countries, SW estimated to be able to make the most impact in Mozambique. SW started operating in Mozambique before operating in Malawi, the company build-up a stronger network with development agencies and has more experienced staff. An advantage of this choice for both companies is that Mozambique is bigger than Malawi and thus has more potential clients. Because SW operates in Mozambique for over two years now, the first customers are ready to upgrade their current systems.

The target group is mid-income people living in rural areas in Mozambique.
The decision of a target group to introduce the MTego also followed directly from the partnership between PreMal and SW. For PreMal, this is their desired target group. The company planned on reaching vulnerable BoP consumers in rural areas because this is the group of people that can experience the biggest impact from the MTego. Field research validated that this group has a disposable income to spend on a SHS and malaria prevention techniques.
It was also found that people from this group value their quality of life and would invest in potential means to increase it. Mid-income means between €200 and €400 monthly household income, this is needed to be able to support the family and afford a SHS. According to the questionnaire amongst 29 people, the mean average monthly healthcare spending is €16, of which €9 is reserved for malaria related healthcare.

Only target people that are not connected to a centralised energy grid.
This decision also followed directly from the partnership between PreMal and SW. It is SW's strategy to target rural areas that are not connected first. If the rural, not-connected market eventually becomes saturated, SW plans to reach people that are connected but do not experience a stable electrical energy supply yet. However, because of the low percentage of people connected in SSA (I.e. in Malawi only 10%), the target group would only grow slightly when including connected people. It should also be noted that of the people that are currently connected, most (42% in Malawi) live in urban areas where people experience less

health issues due to malaria compared to rural areas where 4% of the population in Malawi is connected to electricity (SEforALL Africa Hub, 2018).

The MTego fits in the product portfolio of SW.

The product does fit in the product portfolio of SW. Four reasons in favour could be identified and two reasons why it would not fit.

The reasons in favour are: selling the MTego advertises the social responsibility of SW (1), healthy clients achieve a stronger social and financial position and thus more prone to paying-off their contracts (2), the product does not overlap with other add-on products that the company offers (3), and it is expected that adopting this product will be profitable for SW because it enables them to increase revenue per client (4).

The reasons why the product might not fit with the portfolio of SW are: the product is new and has not been tested for long-term field use which means that the quality is not guaranteed to be as high as that of the other products that SW sells (1), and further research is needed to prove that the trap reduces malaria cases (2).

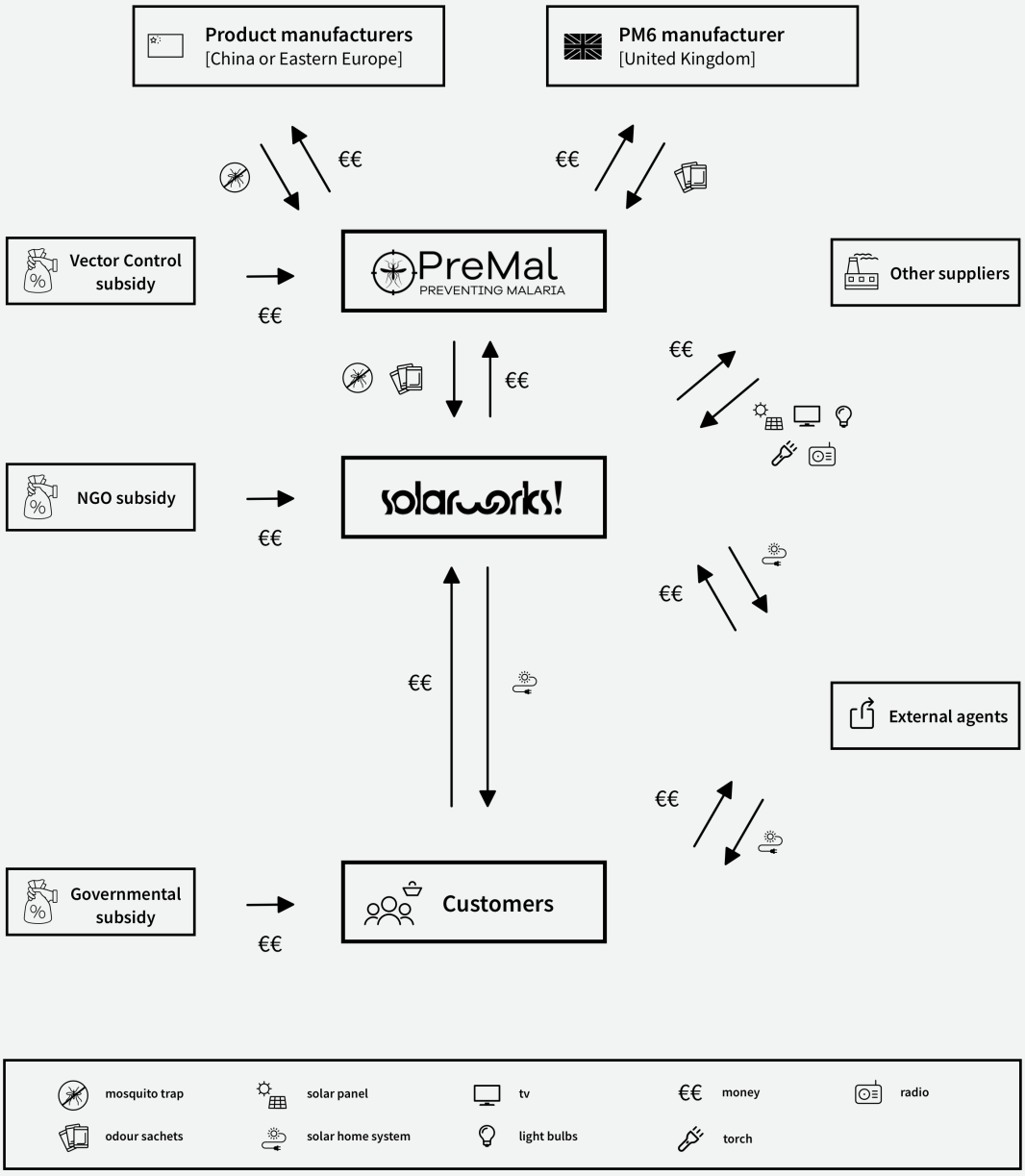


FIGURE 25: **BUSINESS MODEL REVENUE STREAMS**

Distribution strategy

SW is responsible for the distribution of the MTego mosquito trap.
This decision is directly related to the partnership between the two companies. It was the main reason that PreMal partnered-up with SW; because of PreMal's lack of resources to setup distribution channels and infrastructure themselves. This responsibility means that SW handles the promotion, sales, installation, warranty, repairs, and end-of-life of the product. SW is used to this responsibility as the company distributes products of other manufactures in the same way.

SW is responsible for the distribution of the PM6 odour sachets.
This decision also followed from the partnership. Customers need to pick up their odour sachets every three months in the stores of SW. Customers should be able to prove that they are not behind on their payment plan to receive a new bag of odour for their trap.
During field work, the target group unanimously said not to be willing to store a supply of sachets at home because children might play with them (1), the sachets might be exposed to pests (2), and they could be misused for other purposes (3).
For SW, storing the odour sachets at their store decreases the risk for the company in two ways: it provides for an incentive to pay for the next month (1), and it eliminates the stock of odour sachets that people have in their houses, which are at risk when a repossession has to be performed (2). Therefore, sachets will be stored at SW stores available for pick-up by SW customers.
SW needs to sell odour sachets at least two years after that they stopped selling MTego's in an area for customers to be able to use their MTego as it was designed. Furthermore, it is SW's responsibility to make sure that the odour sachets are available at all times in regions where MTego's have been sold.

Using a Product-Service-System to sell the MTego with PM6 sachets as a SHS add-on product.
One of the main benefits of using a PSS is that it enables SW to offer a product to be paid off in multiple instances. This way, a broader audience is reached that can afford the MTego.
The MTego needs a refill of PM6 odour sachet every three months. Because the MTego needs this refill, the customer and distributor need to be connected during the lifespan of the product. This is another reason why a PSS should be used. This refilling of odour sachets provides a stable recurring revenue for both PreMal and SW. Providing a stable recurring revenue is also one of the beneficial characteristics of a PSS. Furthermore, Diehl & Christiaans (2015) highlighted benefits of using PSS for the customer, the manufacturers, governments and society. Goedkoop, van Halen, te Riele & Rommens (1999) add that PSS allow for an increased quality of goods and services due to both combining them and the warm relationship between the customer and the distributor. "The buyer usually pays a premium for carefree usage of the product, and the supplier can make a profit if their products are of high quality and need little maintenance". These arguments support the choice to use a PSS for to sell the MTego with PM6 sachets as a SHS add-on product.

Start with a pilot program for the market introduction of the MTego.
A pilot program is advised for SW to show development agencies that the trial program in Malawi can be replicated in similar rural areas in Mozambique. It has been validated with SW that this program is needed for further implementation of the MTego. Success can be measured by satisfied customers experiencing better health and less mosquito discomfort. This way, impact on people's life is made.
Support for this strategy can be found in literature; a pilot program can be seen as a 'learning phase' for new products and strategies (Naslund, 2010). This applies for the MTego PSS pilot program too, the PSS can be tweaked and optimized after every pilot program. Cheatham (2017) adds that pilots help organisations learn how a large-scale project would work in practice. When applying this literature to the MTego project, a pilot could show that implementing the PSS in one community works. Assumptions can then be made about deploying this on a larger scale.

Payment model

The use of PAYG as a payment method.
A PAYG loan is a safe way to offer credit because the product itself is used as collateral and will not function if the customer is not able to keep up with payments. In the case of the MTego, the SHS will stop functioning which also disconnects the MTego from its energy supply. Furthermore, PAYG loans are used to offer products to customers that could otherwise not afford them. This is morally accepted because SHS and add-on products can improve people's lives by providing light at night, clean electricity, and access to information like the news. PAYG payments are oftentimes made using mobile banking services, but in the case of SW, customers can also pay monthly installments in cash. People in Malawi and Mozambique are used to mobile banking services, as can be found in an article by Nyirongo, where he explains that more Malawians use mobile banking services than formal banking services (2017).
A PAYG contract has a duration of x months and the number of payment installments is x+1. The additional installment is the down payment that has to be made to activate the contract. This makes for a three-month PAYG contract to have four payment installments. According the SW, the rule for calculating the DP is by taking 10% of the selling price of a contract as down payment. This percentage was calculated to be able to cover for the costs of sales, installation and potential repossession. With this amount SW covers for the risk of customers not being able to keep up with monthly payments. Although the DP is set at a minimum of 10% of the selling price, it is assumed that higher DP's can also be applied. A higher DP has the advantages that it decreases people's monthly costs (1), while decreasing SW's risk of people not paying (2). A disadvantage to be taken into account is that it increases the barrier to make a sale on a product. The last rule that applies to the DP is that it is not common to have a lower DP than that the monthly costs are. In this case, the DP should be the same price of a monthly installment.

The purchase price of one MTego will be €40,-.
PreMal advices this purchase price of €40 per MTego to SW. The purchase price is the amount of money that SW would pay PreMal for one product. A purchase price does not include all costs to get a product to the country where it can be sold, in this case Malawi or Mozambique. This price is called the landed cost of a product and includes: product price, shipping and handling, import tax, and excise duties. In the case of the MTego, it is estimated that the landed cost will be €49,56 (see Figure 26 on page 61).
The selling price of the product can then be calculated using the gross margin principle. SW aims to retain half of their revenue made with sales to cover for the costs of running the business and make a profit. If the MTego would be purchased for €49,56 (landed cost), the product must be sold for twice that amount, being €99,12 (selling price). If the landed cost (€49,56) would be deducted from the selling price (€99,12), 50% of the selling price is left. This is the amount of gross margin that is made with the sale.

The purchase price of one PM6 odour sachet will be €3,-. PreMal also advices the purchase price of one PM6 sachet being €3,-. To these sachets, the same principle applies as to the MTego; purchase price is used to calculate landed cost and landed cost is used to calculate the selling price by applying the gross margin principle.
For the PM sachets the landed cost is estimated to be €3,71 (see Figure 26), which would result in a selling price of €7,41. A new odour sachet has to be provided every three months. The MTego should never be sold without a sachet, so the minimum number of sachets is one. A six-month contract comes with two sachets and an eighteen-month contract comes with six odour sachets. The odour sachets are included in the service that SW offers with the product.

Months	Sachets	Landed costs MTego	Landed costs PM6	Total landed costs	Gross margin	Selling price *
6	2	€ 49,56	€ 3,70	€ 56,97	**50%**	**€ 113,94**
18	6	€ 49,56	€ 3,70	€ 71,79	**50%**	**€ 143,57**

* prices without interest and risk factor

TABLE 8: **PACKAGE PRICING**

The target group will be divided in two groups to target separately.

The target group can be divided in two groups, of which the first are people that do not own a SHS (1), and the second are people that do own a SHS (2).

Both PreMal and SW prefer selling the MTego in a package with a SHS. For SW the main reason is that the company want to keep their product portfolio simple and understandable. BoP customers are not used to buying technology yet so they should not be overstimulated by the amount of options to choose from.

The package price can also mask for the relatively high price of the MTego, while the package with a MTego would still be priced in between a SHS without and a SHS with a TV. Although a package would be the preferred way to sell the product, it would exclude current SHS owners (group 2) from the offer. Thus, this group receives a different offer for the MTego without SHS.

Group 1 has the MTego offered in a package.

The package that will be offered to the first target group will include a SHS with four bulbs, a radio, a torch and the MTego mosquito trap.

This group can choose between a basic system (SW80L), a system with the MTego (SW80 MTego), and a system with a 24'' TV (SW80 TV). Half of the field work respondents in Malawi (50%) said to choose the MTego over a tv when they would have been mutually exclusive. "You can't watch TV when you are sick because of the mosquitos." One man was quoted. This validates the demand for the product; if between 10 and 20% of these customers would buy the product, around 1000 products can be sold yearly in Mozambique.

The current selling price of the SW80 Lite package is €190. As seen in Table 8, SW pays €71,79 for the MTego with six odour sachets. The selling price for the MTego with eighteen months of service was calculated using the gross margin rule at €143,57.

Months	Total interest and risk rate	Yearly interest and risk rate
3	2,5% *	10% *
6	5% *	10% *
12	10% *	10% *
18	21%	14%
24	38%	19%
30	52%	21%

* assumed rates based on known months

TABLE 9: **INTEREST AND RISK RATES FOR DURATION OF CONTRACTS**

System	Selling price
SW20	€ 103,00
SW80 Lite	€ 188,00
SW80 MTego	€ 331,57
SW80 + TV	€ 541,90

TABLE 10: **SW PRODUCT PORTFOLIO WITH MTEGO PACKAGE ADDED**

Contract period	Price	Contract price	Monthly price	
			Down payment	*Monthly payment*
18 months	€ 331,57	€ 401,20	€ 33,16	€ 20,45

TABLE 11: **SW80 MTEGO PAYG PAYMENT PLAN**

Contract period	Price	Contract price	Monthly price	
			Down payment	*Monthly payment*
No contract	€ 106,53	-	-	-
3 months	€ 106,53	€ 109,19	€ 27,30	€ 27,30
6 months	€ 113,94	€ 119,63	€ 29,91	€ 29,91

TABLE 12: **MTEGO NO PACKAGE PAYMENT PLAN**

If the MTego would be added to the SW80 Lite package, the total package price could be calculated by combining the selling price of the SW80 Lite system with the selling price of the MTego with six odour sachets. The sum would be: €190,00 + €143,57 = €331,57. This price is about one month of income for an average family, which means that it can be considerate affordable if spread over multiple instances using PAYG services.
For spreading this price over multiple instances, an eighteen-month contract is recommended because this compromises a long duration with a high monthly price. For contracts, two different prices should be taken into account. The first of which is the selling price of the contract; this is the price for the package if it is paid in one go. The selling price of the SW80 MTego package would be €331,58 (see Table 10 on page 59). However, most BoP customers are not able to pay this amount of money in one go. Therefore, PAYG services are used to enable customers to pay the contract in multiple instances. Spreading payments comes with extra costs; interest and risk rates need to be applied to the selling price of a contract. The total price that customers will pay over the duration of their contract is called the contract price. When applying the interest and risk rates from Table 9 on page 59 (21%), the contract price for the SW80 MTego package is set at € 401,20.
The 10% DP rule is applied to the normal price of this package, the DP for this contract will be €33,16. Subtracting the DP from the contract price and dividing the resulting sum over eighteen months, the monthly price to lease the SW80 MTego package becomes: €20,45. See Table 11 on page 59 for an overview of this contract.

Group 2 has the MTego offered without a package.
The group of people that already own a SHS receive an offer for the MTego without a package. This offer will be communicated when the second target group almost finished paying off their current contract. The offer for the second target group includes an MTego with either three or six months of service, depending on the chosen payment method. Two payment methods will be offered; the MTego can be bought in one go, or offered with a short PAYG based contract with a duration of six months. The latter is offered with six months of service to cover for the duration of the contact.
The product is offered at the moment that people paid off their current plan is because people do not want to add credit to credit and will thus not accept another loan before they paid off their current one. Furthermore, it can be assumed that the product can be sold in one go because most farmers receive their yearly income after harvesting and selling their crops.
From the perspective of both PreMal and SW, it is advised to earn back the cost price of the product as soon as possible to decrease risk. A shorter contract period is also beneficial for the contract price in two ways, less odour sachets result in a lower selling price (see Table 8 on page 58) (1), and a shorter contract period results in less interest and risk costs (see Table 9) (2). Although this advice, eighteen-month contracts still have to be offered because people can not afford higher monthly costs and want to decrease their risk of not being able to pay for the coming month.
It is assumed, from the known rates of Table 9 on page 59, that the six-month contract can get away with as little as 5% increase of interest and risk rate from the selling price to the contract price. Furthermore, the assumption is made that adding a 3-month contract in between would not help keeping the portfolio clear and understandable (1), and the monthly costs will be high due to only spreading over 4 instances instead of 7 (2). See Table 12 on page 59 for an overview of the proposed short-term PAYG contracts.

The MTego can potentially be subsidised.
Three types of potential subsidy can be identified. Of these three, the second and the third – NGO subsidy and vector control subsidy – have the most potential to be successful.
Potential subsidies are:

- Governmental subsidy. Governments can provide subsidy to their residents for acquiring SHSs. It is not validated if customers can and will be spend this subsidy on an add-on product like the MTego.
- NGO subsidy. NGO's like USAID provide subsidies directly to SHS provides to be assist in making SHS more affordable. This way, NGO's increase access to clean sources of energy in a country or region. It is not

LANDED COST

Landed cost is the price for a product once it has arrived at the buyer's country of destination. The landed cost includes the initial purchase price, shipping costs, shipping insurance, import tax and excise duties. For the landed cost of the MTego, an estimation has been made with accessible information.

The initial purchase price is advices by PreMal and does not change. The shipping costs have been estimated by PreMal. According to PreMal, shipping one container full of MTego's would costs as little as €1,- per product. When adding costs for shipment on the road towards SW offices, shipping is estimated at €1,50 per product for the MTego. For the PM6 sachets, where shipping a full container would costs less than 10 cents per sachet, the estimated shipping costs per sachet are set at 10 cents.

Shipping insurance is advised and relatively inexpensive. Insuring cargo goods costs as little as 0,15% of the shipped value (ShipHub, 2020). For the MTego's this results in an additional six cents per product, and for the PM6 sachets it increases their landed cost with half a cent.

Import taxes in both Malawi and Mozambique are set at 20% of the value of goods imported. For the MTego this means an addition to its price of €8 and for the PM6 sachets it means adding €0,60.

SW expected excise duties to be applied to both the MTego and the PM6 sachet but detailed information about the amount of these duties was not avaliable. Table 13 shows the sum of costs.

Product	MTego	PM6 odour sachet
Purchase price	€ 40,00	€ 3,00
Shipping costs	€ 1,50	€ 0,10
Shipping insurance (0,15%)	€ 0,060	€ 0,005
Import tax (20%)	€ 8,00	€ 0,60
Excise duties	no info	no info
Landed price	**~ € 49,56**	**~ € 3,70**

TABLE 13: LANDED COST ESTIMATION

FIGURE 26: LANDED COST ESTIMATION

validated if NGO's want to subsidise add-on products like the MTego.

– Vector control subsidy. The Vector Disease Control International (VDCI) organisation provides funding for: prevention and education (1), surveillance and testing (2), and for vector population control (3). This is not the only organisation that provides grants. Chances are that one of these organisations see potential in the MTego and is willing to provide funding. SW has experience with NGO subsidy and expects to be able to receive it for the MTego in Mozambique, where they have existing connections with NGO's.

Promotion plan

Traditional promotion and sales techniques are advised for the MTego in rural Malawi.
The MTego is an innovative product that sparks the attention of people in rural areas in Malawi. These people show to be genuine interested in the product and take time to listen to the sales agent providing instructions about it. People take time to make a decision and are not easily triggered to make an impulse purchase. Together with these findings, a low adoption rate of smartphones and TV's was observed in Malawi. Therefore, it is advised to continue with the traditional way of promoting products that SW currently executes. An example of this promotion style can be seen in Figure 27, where a flyer by SW is shown. Whith this flyer designed by SW in mind, a set of two posters was created that could be used to spread throughout the trade centres in Malawi. This set (Figure 28 & Figure 29 on page 65) is meant to display next to each-other.

It is advised for SW to start experimenting with modern, digital promotion and sales techniques.
It is advised to SW to start experimenting with the use of modern, digital sales and promotion techniques for all their products in the coming two years. The adoption of smartphones and televisions provides companies with new, targeted ways of reaching people. In this case, parallels can be drawn to the western world where these techniques are embedded in marketing strategies already and have proven themselves. Currently, about one-third of adults in Ghana, Senegal, Nigeria and Kenya own smartphones, and smartphone ownership is increasing across SSA (Silver & Johnson, 2018). The assumption can be made that percentages of smartphone ownership in Malawi and Mozambique will follow these countries soon and SW can benefit from this trend if prepared for it.

It is advised for SW to not focus on phone marketing for the MTego.
Results from a trial amongst 12 participants in Malawi support the advice not to recommended phone marketing to sell the MTego in Malawi. The findings that potential clients are not used to making big purchases and will not do so without evaluating the product with their own eyes and hands (1), that people discuss a potential purchase with their family members (2), and that people do not take a new loan before they paid off their current loan (3), argument against it. Although selling the product via telephone might not be effective, this method could be used to spark people's attention.

Use protection against mosquitos as a USP in the promotion of the MTego.
Because there is not enough scientific evidence (yet) to advertise the MTego as a device that decreases malaria, other unique selling points should be highlighted in the promotion materials. Results from field work show that people feel protected by the trap. Therefore, it is advised to use this as a theme in promotion materials. Figure 28 & Figure 29 show examples of how this theme can be used for posters.

FIGURE 27: **SW PROMOTIONAL FLYER MALAWI**

FIGURE 28: **1 OF 2 MTEGO PROMOTIONAL POSTERS**

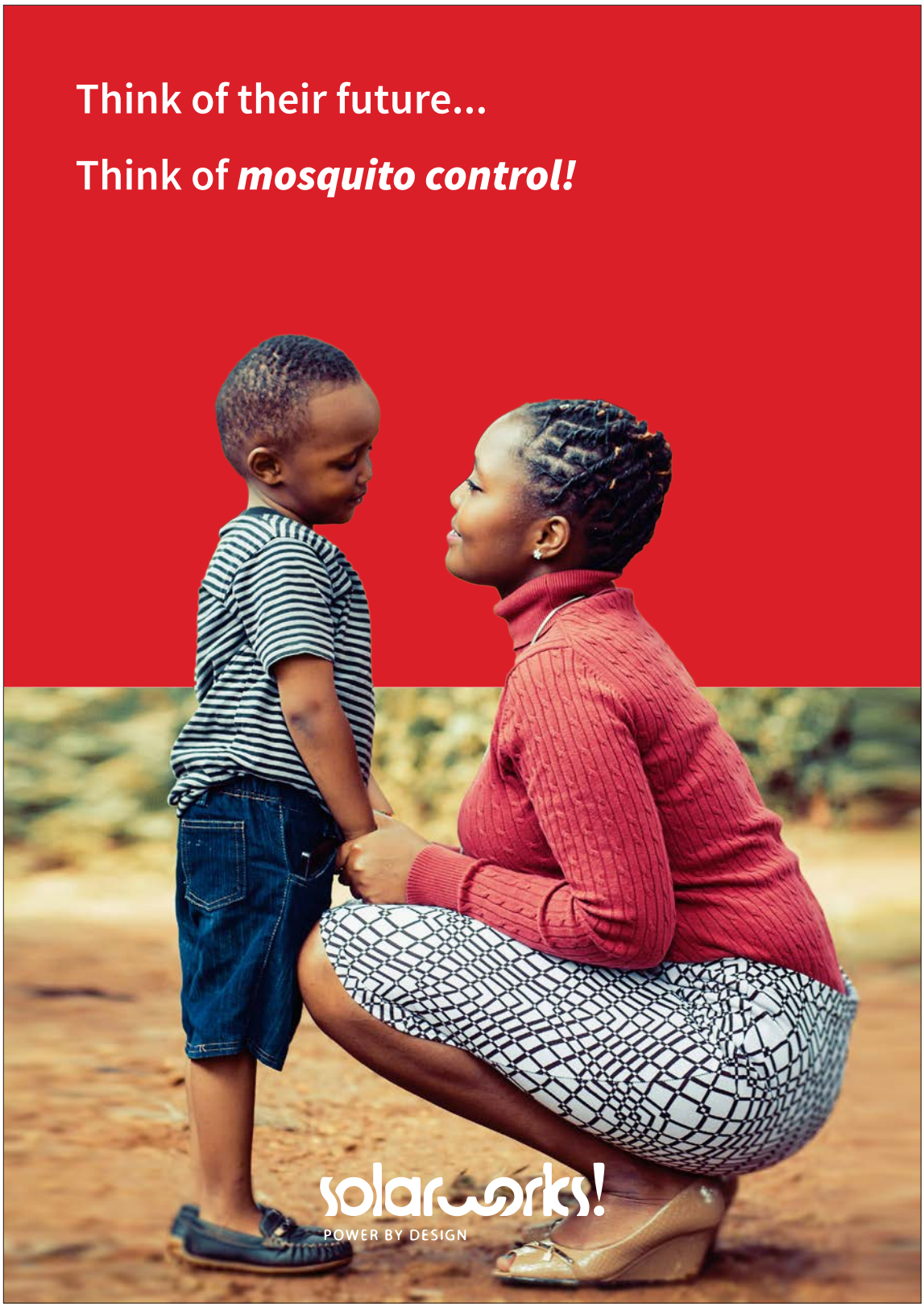


FIGURE 29: **2 OF 2 MTEGO PROMOTIONAL POSTERS**

Warranty and repairs

The MTego should be sold with two years of warranty against manufacturing defects.
According to SW, it is common practice for distributors to be responsible for keeping their products operational at least for the duration of the contract. This not only because customers do not pay their monthly installments for broken products, but also because it is seen as morally mandatory when operating in a market with vulnerable customers.
Although European rules to protect customers do not apply in Malawi and Mozambique, it is advised to provide two years of warranty with every MTego sale.

PreMal is advised to provide at least 2% of replacement parts with every shipment.
Manufacturers assist distributors in the process of keeping their product operational in the field. The way manufacturers should assist is by providing at least 2% of additional parts with every shipment and provide training on how to repair the product if necessary. This 2% is set as a rule of accepted products that break down due to manufacturing defects. It is advised for PreMal to follow this rule and provide these extra products and training for SW installers on how to repair PreMal's product. In return, PreMal will not be bothered with claims of broken products. If more than 2% of products break down, both companies should negotiate about the amount of replacement parts that can be delivered.

SW is advised to repair the MTego in the field or in their offices.
It is in the nature of a distributing company to maintain the distributed products. Not only because PreMal does not have infrastructure in the countries where their products are distributed, but also because this is included in the risk of the distributor and covered for by the gross margin applied to the product prices.
The repairability of the MTego comes as a benefit for all stakeholders as all components of the trap can be replaced without much technical knowledge. Figure 31 illustrates the simplicity of an older version of the product. This means that it will be cheaper for both PreMal and SW to keep the MTego traps operational because only spare parts have to be delivered to SW, not complete systems.
For the customer, this also comes as a benefit because in the event that their trap breaks down and the reparation cannot be claimed under warranty, the costs for replacing a part will be manageable. In this case, it is up to SW to decide whether they cover the costs of the repair or that the customer is held responsible.

FIGURE 30: **ILLUSTRATION OF SW INSTALLER**

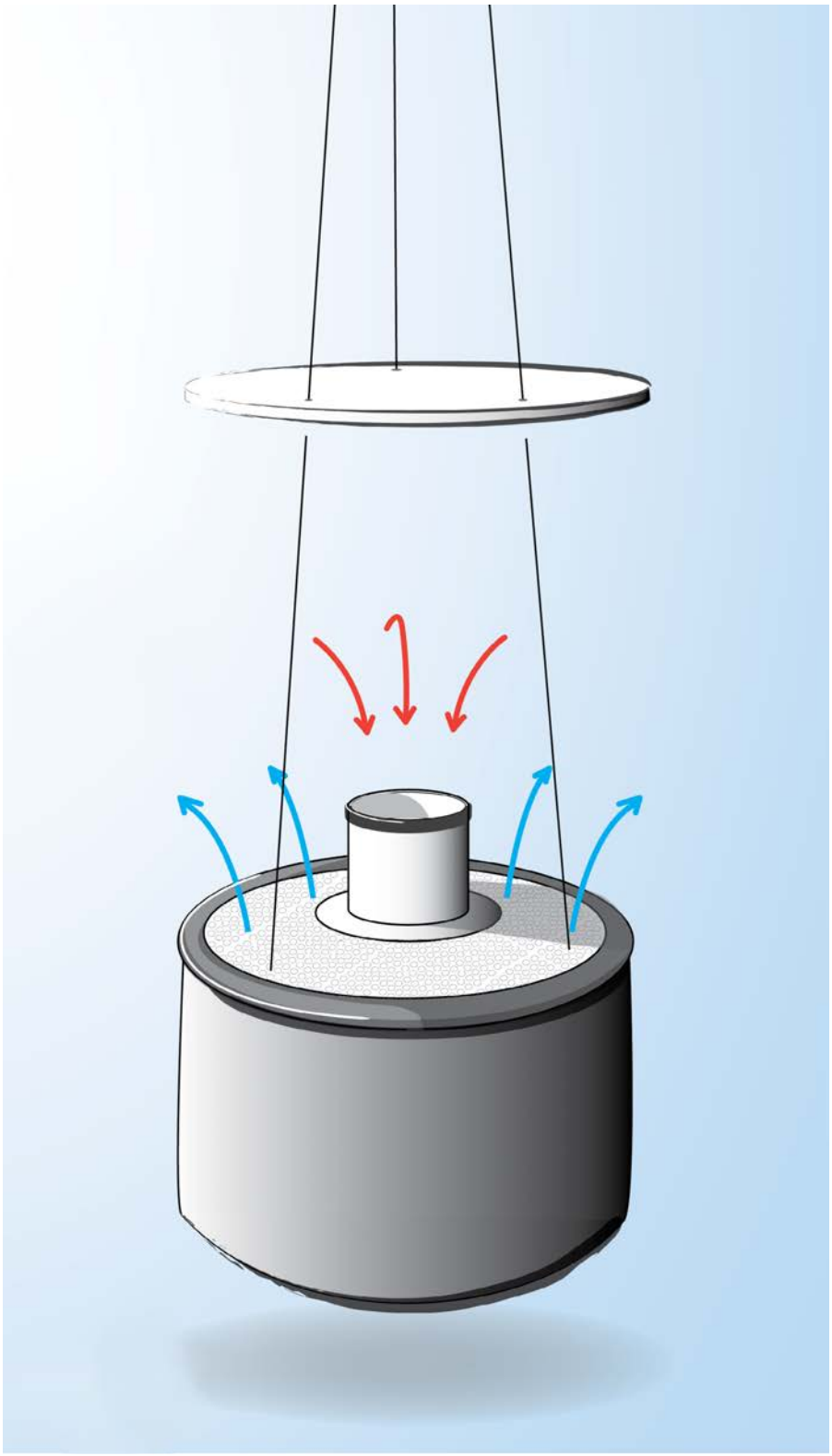


FIGURE 31: **MTEGO ILLUSTRATION BY FAIRBAIRN - 2018**

Shipping and financing

The MTego and PM6 sachets will be shipped FOB Shipping Point.
According to both SW and PreMal, it is common practice for manufacturers to ship products Free On Board (see Figure 33 for an introduction to FOB). For the MTego and PM6 odour sachets, FOB Shipping point is advised. Shipping FOB Shipping Point means that the manufacturer, or seller, is responsible for delivering the goods 'on board', this includes shipping from factory to port and fees that come with it. The distributor, or buyer, in turn, receives responsibility for the costs and risks that come with shipping the goods after that the product is placed 'on board'.

PreMal should organize shipping to country of destination.
Although FOB practice, SW advised the PreMal to organise shipment towards country of destination and and charge SW for their part. For both the MTego and the PM6 odour sachets, these practices can be followed. From PreMal's perspective, this organising of the shipment can be seen as a gesture towards the client and an investment in a long-term relationship.

The minimum batch size that can be ordered contains 100 MTego's.
Due to the fact that PreMal does not have a stock of MTego's, the company must produce upon order. PreMal is currently negotiating with producing companies, but expects not to be able to produce in batch sizes smaller than 100 products. A bigger batch size results in lower productions and shipping costs and is therefore advised.
Although advised to order in batches bigger then 100, the decrease in costs comes with an increase in risk for SW. SW risks not being able to sell ordered items. Therefore, it is adviced towards SW to plan their orders in detail.

PreMal should use flexible payment terms.
As for most companies, payment terms are important for SW to keep their cash-flow healthy and use as little capital injections as possible. It is general practice to pay a percentage (50%) of the order to confirm it, and to provide for the manufacturing party to acquire materials needed for production and set-up production. After the products have been delivered in country of destination, the buyer needs time to sell them before paying-off the resulting 50%. The buyer can be given another 45 days after arrival of the products to pay the resulting sum. This practice is also advised for PreMal to apply when handling an order of SW.

FREE ON BOARD

FOB is used in international shipping contracts and includes the time and place of delivery, but also when the risk of the goods shifts from seller to buyer (Nickolas, 2019). FOB can be used in two ways: *FOB Shipping Point* and *FOB Destination*.

FOB Shipping Point

FOB Shipping Point means that the seller organises and finances transport from factory to ship, and the responsibilities move to the buyer when loaded on the ship. This moment refers to the 'shipping point' in the name. Costs for the shipment, import taxes and excise duties all shift at the shipping point. So does the ownership of the goods in the books of the companies buying and selling them.

FOB Destination

FOB Destination works according to the same principle, however, the moment that responsibilities and costs shift from buyer to seller do not shift when the goods are placed on the boat in the harbour of departure, they shift when the goods arrived in the harbour of destination.

Obligations

(AIT Worldwide Logistics, n.d.)

Seller's Obligations

- Goods, commercial invoice and documentation
- Export packaging and marking
- Export licenses and customs formalities
- Pre-carriage and delivery
- Loading charges
- Delivery onboard vessel at named port of shipment
- Proof of delivery
- Cost of pre-shipment inspection

Buyer's Obligations

- Payment for goods as specified in sales contract
- Main carriage
- Discharge and onward carriage
- Import formalities and duties
- Cost of pre-shipment inspection (for import clearance)

FIGURE 32: **FREE ON BOARD DEFINITION**

5. Evaluation

Limitations

With regards to the field-work research conducted in Malawi, several limitations towards the repeatability and generalizability of this study arise. First of all, small sample sizes were used because of difficult access to more people. Then all of the field-work has been conducted in the Dowa and Lilongwe district of central Malawi. It is possible that a different region or country within SSA would have lead to different study results. The accuracy of the study results can also be questioned because of the language barrier that existed between researcher and participants. Most results have been translated from Chichewa to English and people have not been able to fill-in the study questionnaire in their native language. For further research, it is recommended to overcome these limitations by researching amongst a bigger group of participants spread over multiple regions. Furthermore, it is recommended to create a questionnaire and other study materials in the native language and have participants answer in this language as well. Using a translator is expected to be more reliable than the fluency in English of study participants in Malawi.

The prices mentioned in this report are estimations based on assumptions because the actual prices are dependent on factors that are difficult to predict. One factor that influences the price of the MTego substantially is the volume in which the product can be produced and shipped towards distributing companies. If PreMal is able to access multiple sales channels and increases production volume, the price can be reduced. The same applies to the shipping and import costs for the MTego. Shipping in bigger volumes leads to a lower price per product. Because import and excise duties differ between Malawi and Mozambique, and differ per product category, the amount of duties has only been approached during this project.

Another limitation of this project has been the limited evidence available on the effectivity of the MTego mosquito trap with regards to reducing malaria cases. Previous research has shown that mass trapping considerably reduces mosquito populations resulting in up to 30% reduction in malaria cases (Homan et al., 2016). However, this research was conducted using Biogents Suna trap, of which the design deviates from the MTego. The lack of evidence makes the promotion of the trap reliant on what is known about the trap; that it reduces mosquito annoyance. PreMal is currently working on generating more results with their trap by providing it to researchers so it is expected that this limitation will be resolved in the future.

The proposed strategy is limited because of the high price that the customer needs to pay for the product. To reduce the costs for the customer, the MTego needs to be either subsidised by development agencies or receive vector control subsidy. These two forms of subsidy would make the product more affordable for the customer. A more affordable product is needed to reach a bigger target group and achieve PreMal's goal of reducing malaria cases by mass trapping mosquitos. It was out of the scope of this project to organise subsidy.

Recommendations

PRODUCT PRICE REDUCTION

One field research conclusion was that the price of the product was on the upper limit of what people would be able to or willing to pay for it. It is assumed that potential customers will not buy the product because it is considered too expensive. Decreasing the product price would have multiple benefits for the three main stakeholders. A lower price has a snowball effect on the number of products sold. The target audience increases and more products can be sold. When more products are sold, the costs of production and shipping decreases again due to economies of scale. A bigger target audience results in more healthy people; which means more impact.

It is thus recommended to decrease the cost price of the product, where a small change results in big differences for the customer. However, technical adjustments to the product were out of the scope of this project and have not been handled.

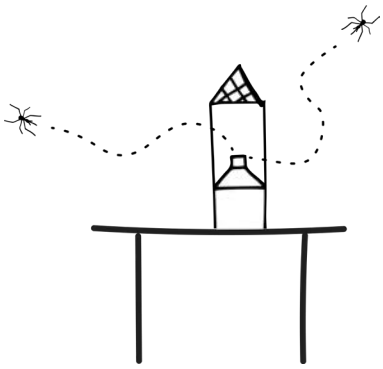
MTEGO INDOOR EDITION

It is recommended to study the feasibility of an indoor edition of the MTego. During field research, three reasons why customers would prefer a trap to work inside over outside were mentioned: it would be safe from criminals (1), it would be safe from weather influences like tropical storms (2), and it a smaller trap could be produced at a lower price which would be beneficial for customers too (3). Arguments against an indoor edition of the MTego are that estimates show an increase in outdoor biting (Sherrard-Smith et al., 2019) (1) and the high costs of developing and testing a new version of the trap (2). The increased outdoor biting behavior, potentially due to indoor interventions, leads to more malaria transmission which could amount to 10.6 million additional malaria cases per year. This highlights the importance for outdoor vector control.

The costs of developing a new product are high because of the way that this product has been designed and developed. This method makes it difficult to make fundamental design adjustments. Changes to key features should be tested before implementation. Testing requires mosquito rearing and lab time which is difficult to get for commercial parties.

MTEGO VILLAGE PACKAGE

Another thought was that the MTego might work best when a couple of houses in near vicinity to each other have one installed. This thought is related to theory from the SolarMal trial where clusters of houses on Rusinga Island in Western Kenya were provided with odour-baited mosquito traps and a decrease of malaria prevalence of 30% over one year was measured against control groups (Homan et al., 2016). If the MTego proves to be effective enough to provide more than just one household with its benefits, a group of households could acquire several MTego's and place them between their houses. This idea can also be interesting for development agencies looking to reduce malaria cases. It should be noted that the traps still need a source of electrical energy which can be supplied in several ways. Further research into the number of traps needed per community is recommended.



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Appendices

Appendix A - **Field work observations**

ELECTRICITY

As seen in Figure 33, Malawi does have a centralized energy grid to which some houses and businesses are connected. On average, about 10,8% of households is connected to the grid where in rural this number is as low as 1% and it goes up to about 46% in urban areas. The grid connection is unstable and relies heavily on hydroelectric energy generated in Zambia. Regular power outages occur even in the rain season. In times of draught, power outages of over 24 hours can even occur. It is for this reason, that even houses and businesses connected to the power grid, buy solar home systems to guarantee stability by having their own supply of energy. In rural areas, people do not have the ability to use clean cooking fuels, as can be seen in Figure 36, charcoal stoves are used to cook meals.

WATER

Figure 34 shows a water pump that can be found throughout Malawi, these pumps are generally speaking provided by NGOs and supply clean drinking water to a large amount of people living close to it. The pump filters the water from the well and has an almost unlimited supply of water. In Malawi, the water from the tap is relatively clean and those who have access to tap water drink this.

HEALTHCARE

Public hospitals and medicine are free in Malawi, but that does not mean that people do not spend money on health expenditures. A free visit to the hospital still costs travel expenses and lost days of work. People also self-diagnose and buy medicine at local stores to avoid the hassle of going to the hospital. It can be a challenge to go to a hospital when a person does not have their own means of transport, the hospital is not nearby and people have to wait a long time before they can be treated.

RELIGION

In Malawi, Christianity is by far the biggest religion. According to a study by Too (2017), Christians make up for 75% of the religious people in the country. Amongst these 75%, Protestants are the biggest group with 44% of the religious people in Malawi. Roman Catholic people are responsible for 18% of religious people and other Christians make up for the resulting 13%. The next biggest group of people are Muslims (19%), followed by other religions (6%). On a Sunday morning, most Christian go to church to pray and sing songs together.

FOOD

The staple food of the country is Nsima, this is a maize porridge that can be combined with meat, fish and vegetables (See Figure 34 for 'Nsima Beef Stew'). Nsima is widespread in the continent and is goes under different names in different countries, some of them are: Ugali, Pap, Mieliepap, Sadza or Kwon. This type of food provides for carbohydrates that bring you through the day, but does not make for a healthy diet when not varied with other dishes.

FIGURE 33: **ELECTRICITY GRID**

FIGURE 34: **WATER PUMP**

FIGURE 35: **NSIMA BEEF STEW**

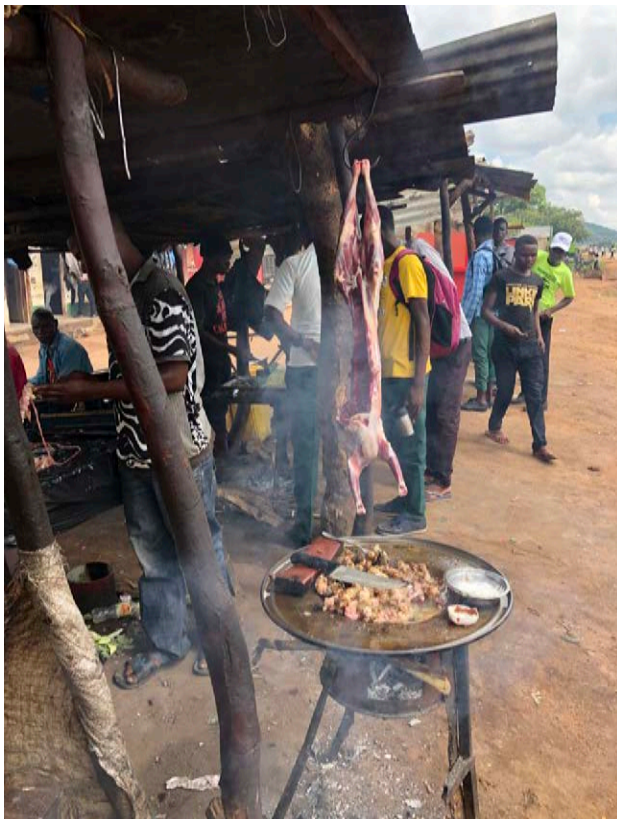

FIGURE 36: **COOKING ON CHARCOAL STOVE**

Appendix B - **Customer questionnaire**

solarworks!
POWER BY DESIGN

This questionnaire has been developed to gain a better understanding of clients of SolarWorks! The aim is to get a picture of what is important for people in Malawi and to adjust our promotions and propositions to it. By handing in this form, you consent that your data will be used for the purpose of this study. The data will be deleted afterwards and personal information is shared anonymously.

General

Where do you live? _____

How big is your family? _____ (fill in a number)

Do you have a job? (select one)

- Yes, I am a _____
- No

How much do you spend on food? _____ (MWK per day)

How much do you spend on school for your children? _____ (MWK per month)

Do you have personal savings (select one)

- Yes
- No
- Prefer not to say

How do you, or would you save money?

_____

_____

_____

_____

Mosquitos

Are you experiencing mosquito nuisance, and how?

_____

_____

_____

_____

_____

How severe is the nuisance that you experience? Rate on the scale below

Not severe				Very severe
○	○	○	○	○
1	2	3	4	5

How much do you spend on medicine and other health expenditures? _____
(MWK per month)

How much of that money is spend on malaria related healthcare? _____
(MWK per month)

Intervention

What do you use to lower the chance of getting infected with malaria? Select one or more:

- Nothing
- Bednets
- Mosquito repellent spray
- Other _____

To what extend do these techniques work? Rate on the scale below

Not at all				Very good
○	○	○	○	○
1	2	3	4	5

Would you be interested in a different malaria prevention technique?

- ○ Yes
- ○ No

Could you explain your answer to the previous question?

This is the end of this questionnaire, please hand it in. Thank you for your participation.

Appendix C - **Upgrade priority game**


TV 24"
$250


Fridge
$400

$25
** FAKE MONEY **


1 Lamp
$30


MTego Mosquito Trap
$100

$25
** FAKE MONEY **


3 Lamps
$75


Hair Dryer
$35

$25
** FAKE MONEY **


Radio
$35


Food Processor
$80

$100
** FAKE MONEY **

Appendix D - **Pricing prototype**

Down Payment

(MWK)

Monthly installments

(MWK)

solarworks!
POWER BY DESIGN

Appendix E - **Questionnaire results**

	A	B	C	D	E	F	G	H	I	J	K	L
1	place_resid	family_size	job_separa	what_job	food_spenc	school_spendin	personal_s	save_cash	save_group	save_busin	save_bank	mosquito_
2	lilongwe ar	5	1	shop supervisor	60000	#NULL!	1	2	2	2	1	1
3	lilongwe ar	4	1	external affairs coc	20000	9700	1	2	1	2	1	1
4	lilongwe ar	6	1	credit controller	180000	100000	2	2	2	2	2	1
5	lilongwe ar	2	1	procurement offic	150000	150000	1	2	2	2	1	1
6	mponela	4	1	primary school tea	60000	50000	2	2	2	2	2	1
7	lilongwe ar	1	1	driver	112500	15000	1	2	2	2	1	1
8	kasungu	7	1	sales lead	30000	#NULL!	2	1	1	2	2	1
9	khwenna vi	4	1	farmer	195000	45000	1	2	2	2	1	1
10	makwami (	6	1	farmer (pensioned	150000	10000	1	2	2	2	1	1
11	kamwana v	6	1	farmer	30000	11000	1	2	2	2	1	1
12	chikuluti	5	1	tailor	60000	10000	1	2	2	2	1	1
13	mponela	1	1	sales agent	60000	#NULL!	1	2	2	2	1	1
14	mponela	5	1	sales agent	75000	#NULL!	1	2	2	2	1	1
15	nthesa	4	1	farmer	10000	15000	2	2	2	2	2	1
16	nthesa	6	1	farmer	20000	30000	1	2	2	1	2	1
17	mpalo	5	1	farmer	15000	#NULL!	1	2	2	2	1	1
18	lilongwe ar	4	1	hotel worker	50000	30000	2	2	2	2	1	1
19	lilongwe ar	4	1	hotel worker	10000	12000	2	1	2	2	1	1
20	lilongwe ar	3	1	waiter	#NULL!	#NULL!	3	2	2	2	2	1
21	lilongwe ar	5	1	photographer	60000	23300	1	2	2	2	1	1
22	lilongwe	2	1	restaurant manage	120000	#NULL!	1	2	2	2	1	2
23	lilongwe ar	5	1	hotel worker	150000	20000	1	2	2	2	1	1
24	lilongwe ar	7	1	hotel worker	110000	24000	2	2	2	2	1	1
25	m'bang'om	3	1	farmer	15000	1000	1	1	2	2	2	1
26	mponela	7	1	sales agent	30000	#NULL!	1	2	1	2	2	1
27	kasangadzi	5	1	sales agent	60000	#NULL!	1	2	2	2	1	1
28	mponela	3	1	sales agent	90000	75000	2	2	2	1	2	1
29	lilongwe	5	1	waiter	45000	8000	2	2	2	2	1	1
30	lilongwe	3	1	waiter	150000	5000	2	2	2	2	1	1

	M	N	O	P	Q	R	S	T
1	mosquito_nuisance_elaborate	mosquito_r	healthcare_	malaria_sp	mp_bednet	mp_coil	mp_spray	mp_doom
2	bites and noise	3	20000	#NULL!	1	2	1	2
3	When bitten by them, we got invovled in malaria and other diseases to	4	5000	3000	1	1	2	2
4	Sometimes i suffer from malaria	3	10000	6000	1	2	1	2
5	Mosquitos are noise and their bites hurt	5	10000	6000	1	2	1	2
6	Mosquitos are all over and i just got better from a case of malaria	4	12500	#NULL!	1	1	1	1
7	It gets worse during the rainy season	2	3500	2000	1	2	2	2
8	It distrurbs me from my sleep, it makes my night long and i wake up tire	4	5000	4500	1	2	2	2
9	The family suffers from malaria almost monthly	5	80000	30000	1	2	2	2
10	We are suffering from malaria more often. Mostly my 2 children, about	3	7000	3000	1	1	1	1
11	They are noisy and bring malaria	4	4000	2500	1	2	2	2
12	When someone has been bitten by mosquito, he or she can suffer from	4	5000	2000	1	2	2	2
13	sometimes the mosquitos bite us during the night	4	7000	3000	1	2	2	2
14	the mosquitos bother us around the house, especially at night	3	5000	2000	1	2	2	2
15	the mosquitos bite my face which makes me to have difficulty breathing	4	15000	10000	1	2	2	2
16	I hardly sleep at night	4	20000	15000	1	2	2	2
17	Bednets only work when i sleep	4	5000	3000	1	2	2	2
18	Mosquitos transfer malaria, i get it almost 2x/yr	5	60000	20000	1	2	2	1
19	The mosquitos transmit malaria, they bite me at night	5	2000	#NULL!	1	1	2	1
20		#NULL!	#NULL!	#NULL!	1	2	2	2
21	The mosquitos bring malaria at least 1x / year	4	1600	300	1	2	2	2
22		1	10000	#NULL!	1	2	1	2
23	My baby gets sick from mosquitos	2	15000	9000	1	1	2	2
24	Because mosquitos bring malaria, this is a dangerous disease for infants	5	6000	2000	1	2	2	2
25	Itchy patches, annoyed by the bites and the family gets malaria about 6	5	8000	4000	2	1	2	2
26	We can not sleep because of the noise and itchy bites from the mosquit	4	10000	5000	2	2	1	2
27	The mosquitos bite me at night when i sleep	5	6000	3500	2	2	1	2
28	i am usually at the night because of the weather changing and and ever	3	25000	15000	2	2	1	2
29	Each and every time I have the problem of malaria in my family	4	8000	6000	2	2	2	2
30	I feel fever because of mosquitos because i don't sleep under a mosquit	5	10000	20000	2	2	2	2

	U	V	W	X
1	malaria_pr	interest_ne	new_prevention_elaborate	participant
2	5	1	I want to have a broad knowledge of malaria prevention technique	1
3	4	1	The use of sprays would be fine because mosquitos are mostly four	1
4	4	1	The preventive methods that i have tried never were 100% safe	1
5	3	1	if you dont have money to replace a bednet and buy repellent spra	1
6	2	1	The repellents that we use now are not that effective, or only for s	2
7	3	1	Just to get to know different techniques and to differentiate	5
8	3	1	I would like to try different techniques because what i use now is st	3
9	3	1	Both family life as economics can be boosted with a better system	2
10	4	1	Lower suffering from malaria, health boost for the family, saves mo	2
11	4	1	change of techniques make a better life, to compare techniques, ec	2
12	5	1	Bednets only help when we are in bed, so i'd like an alternative tec	2
13	3	1	all these questions will help is because […]	3
14	3	1		3
15	5	1	Mosquitos are really bad because it's hard to find money for treatn	4
16	4	1	i would be interested because it is hard to find mosquito nets	4
17	3	1	Bednets only work when i sleep	4
18	3	1		5
19	3	1	I want to see how a new technique works	5
20	5	1	because it will prevent the malaria infection before it can attack me	5
21	4	2	My bednets work good enough	5
22	5	1	I am interested because if there is something new that we should t	5
23	4	1	So many mosquitos. Sometimes they enter the bednet so i would li	5
24	3	1	Since mosquito nets don't work efficiently 24 hours, different techr	5
25	3	1	It's hard to find working techniques, and they are expensive	4
26	3	1	Because the techniques we are useing are not working 100%, so I w	3
27	3	1	i would like to use a different malaria prevention technique becaus	3
28	5	1	i would like to try because i have been using other things so its high	3
29	#NULL!	1	I am interested in a new technique because i hope that it will help r	5
30	5	1	I would be happy if you can share the mosquito nets and malaria m	5

Appendix F - **Questionnaire graphs**