// Healthy Start Lamu //
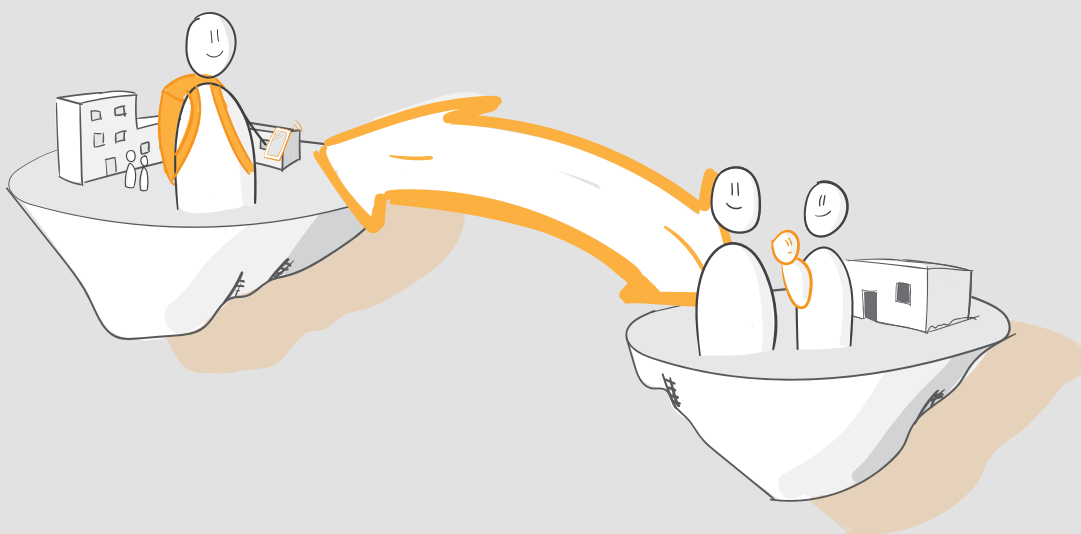
Designing interventions for a healthy and equal starting position in life

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Preface

Before you lies the result of six months of the most interesting and challenging design project I have done (so far). It was a continual process of being outside of my comfort zone as a designer. I picked up new skills such as visual thinking and doing, gained invaluable life experiences by submerging myself in Lamu for 5 weeks, and got to deepen my understanding of design during the discussions with my supervisors, fellow graduation students, and local experts alike.

To start, I want to thank JC and Milene. I couldn't have wished for a more powerhouse of a supervisory team. Your complementary areas of expertise, honest feedback and encouragement throughout the project have been vital to not only the project results, but also to my growth as a designer, for which I am extremely grateful.

Furthermore, this project would not have been possible without the collaboration from the local experts from the Kenya Red Cross Society. I would like to thank Derrick, for your feedback and continual facilitation of connecting me to the local context. Also from the Kenya Red Cross Society, I would like to give a special thanks to Franklin, for accompanying me on various interviews during the fieldwork, to Fatma for her insights and Emmanuel and Nassor for their warm welcome.

Thanks to everyone I got the opportunity to speak with during the fieldwork. This project would not have been possible without your hospitality and willingness to take the time and effort to share your insights.

The fieldwork was an intense period, and I was lucky to have Dorrit and Emma there to share the experience. I am grateful that we got to share such a special period. Special mention to Abud and Abrari, for your friendship during my stay in Lamu.

Also, a big thanks to Delft Global Initiative, FAST and Students4Sustainability, for supporting the fieldwork and for the additional guidance that your questions gave to the project.

Last but not least, thanks to my friends, family and girlfriend for supporting me throughout this master degree. It has been quite a switch from quitting my Mechanical Engineering MSc. three years ago to now graduation from Industrial Design Engineering,. What a great decision that has been and it would not have been possible without your support.

And to you, thanks for checking out this project. Enjoy reading!

Street scene in Lamu town, Kenya

Glossary

Definitions:

Caregiver: Someone who takes care of an infant, usually a parent.

Health worker: Someone who is employed by a health facility or NGO to provide healthcare services

Healthy Start: An initiative between Delft University of Technology, Erasmus University Rotterdam and Erasmus Medical Center that aims to give every child an equal starting position in life.

First 1000 days: The phase of life that ranges from conception up until around two and a half years old

Infant: Children at the age of birth to one year. In this project, infants are defined as up until two and a half years old

Intervention: (In this report) A product-service system that aims to transform a system

Undernutrition: When someone experiences a lack of nutrients

Wasting: A form of acute undernutrition that is defined as low weight-for-height

Stunting: A form of undernutrition that is defined as low height-for-age

Micronutrient deficiencies: A form of undernutrition defined by a lack of essential vitamins and minerals in the body

Remote: Away from health facilities (as in remote healthcare), or far removed (as in remote communities

Abbreviations

WHO: World Health Organisation

NGO: Non-governmental organisation

KRCS: Kenya Red Cross Society

iCCM: Integrated Community Case Management

CHV: Community Health Volunteer

CHEW: Community Health Extension Worker

MCH: Maternal and Child Health

MUAC: Middle Upper Arm Circumference

ANC: Antenatal Care

Executive Summary

This design report focuses on **exploring the opportunities for technology-driven interventions to address health inequalities in children during their first 1000 days of life in Lamu, Kenya.** Children's health during the first 1000 days of life is crucial for their future development and overall health. Interventions that focus on improving health inequalities in the first 1000 days are cost-effective and help to reduce inequalities. In Lamu, Kenya, there is a young demographic and children's health is worse than the national average, due to financial, geographical, and cultural constraints which make it difficult for communities to access quality healthcare. Technologies and innovation could help bridge the gap between communities and healthcare facilities to improve children's health. The main research question that this report aims to answer is "How can we improve the healthy start to life in Lamu using available technologies within the local current context?".

First, **a focus for a health challenge** for this project is found, which had to be a relevant burden in Lamu in the first 1000 days, be culturally relevant, and present opportunities for technology. After mapping and eliminating health risks and problems in the first 1000 days based on these criteria, two health challenges stood out as relevant and offering opportunities: stunted growth and pneumonia. **Experts from the KRCS recommended** reframing stunted growth and focusing on **(un)healthy nutrition**, as it had not been focused on much in the region, was culturally relevant, and had the potential to make a significant impact.

Next, fieldwork interviews, observations and generative sessions were used to **understand the context of (un)healthy nutrition in Lamu**, as well as **the local opportunities for technologies**. Lamu is a diverse region with **strong informal networks** and **social cohesion**, but **food insecurity**, **lack of awareness** on the importance of healthy diets, and **healthcare accessibility concerns** are challenges.

Community Health Volunteers are central in a wider approach to improve community health. Opportunities for technological enablers were found in the widespread adoption of **phones**, as well as the potential for **anthropometric measurement tools** as they are available and affordable.

The opportunities that were found from the context research were used to ideate and describe **six different intervention** scenarios, in which Community Health Volunteers use anthropometric measurement tools to enable various basic nutritional-based health services for children in the first stages of life at the community level. The basics of these scenarios were **evaluated and co-created with Community Health Volunteers** during the fieldwork. The scenarios vary mainly on the purpose of doing the measurements, how the technological enablers are used, and the impact that is generated. Two scenarios, the **community-based growth monitoring scenario and the remote follow-ups scenario**, were selected as the most promising **after evaluation with local experts from KRCS**. Further **evaluation on the desirability, feasibility, and viability** of these two scenarios resulted in the **community-based growth monitoring scenario** being identified as the **most promising**.

One of the main barriers to implementing these interventions is the compensation of CHVs, and ways to overcome this issue are suggested. Finally, recommendations are given for further design and implementation

Report structure

This report aims to explore new opportunities for technology-driven interventions to improve on children's health in the first 1000 days in Lamu. It is structured in five sections. Of these sections, the second, third and fourth make up the bulk of the design work for this project. The first section introduces the project and approach, and the final section concludes the project.

In the first section; *Section 1: Introduction and scoping*, the start of the project is covered. It introduces the topic, stakeholders, research questions and approach that was taken. This includes a short description of why there is a focus on the first 1000 days and what inequalities exist within children's health. It briefly introduces the context of the project, Lamu, and the stakeholders that are involved in the project. Next, the main research questions that help shape the work and the overall approach, including the fieldwork, is described.

Because the scope of the project at the start was too general, a focused health challenge needed to be established. The second section, *Section 2: Focus finding*, explains how the process went from all possible health challenges to one that was relevant in the first 1000 days, culturally relevant and that presented opportunities for available technologies.

In the third section, *Section 3: Understanding Lamu*, the local context is explored and described by understanding it from three different perspectives; the cultural perspective, the healthcare perspective and the technological perspective. Through this understanding, the local needs and opportunities are uncovered.

In the fourth section, *Section 4: Designing Interventions*, the opportunities that have been implicitly uncovered in the previous section are made explicit and combined to form intervention scenarios. These scenarios, which combine the opportunities related to the available technologies and culture and the needs around the local nutritional healthcare, are then evaluated together with local experts and are further evaluated on their desirability, feasibility and viability.

In the final section, *Section 5: Concluding the project,* the project is reflected upon. This entails looking back if the research questions have been answered, what the limitations and recommendations are and to close it all off, how I personally have experienced this project.

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Materials and post-its from an evaluative and co-creative session

SECTION 1

// Introduction and approach //

Chapter 1: Introduction
Chapter 2: Approach

This section covers the start of the project. It introduces the topic, stakeholders, research questions and approach

Chapter 1: Introduction

This chapter introduces the project. To start, the topic of child health inequalities and shows why the first 1000 days are essential. It also introduces the region of Lamu, which is the focus of this project. It then goes into the purpose of this project and who is involved.

1.1 Initial scope

1.1.1 Child health inequality

The focus of this project is on inequalities in the health of young children during their first 1000 days of life. While it is true that the overall health status of children around the world has improved dramatically over the past few centuries, with under five mortality rates more than halved in the past 30 years (Roser et al., 2013), this progress has not been evenly distributed.

These resulting child health inequalities exist on both a global and national level. Looking at a map of infant mortality rates, it is clear that most infant deaths occur in sub-Saharan Africa (figure 1.1). Many children in LMICs are still dying from preventable causes such as malnutrition, lack of access to clean water and sanitation, and inadequate healthcare.

This inequality in child health is especially concerning because it affects the most vulnerable groups of society. There are many factors that can lead to worse health outcomes, such as poverty, lack of access to healthcare, lack of education, and inadequate nutrition. Disparities in health among different socioeconomic groups exist due to economic, social, and geographical barriers (Rebouças et al., 2022). For example, healthcare facilities may be difficult to access or too expensive for most people to use. Health services may also be understaffed and under-equipped.

The United Nations' sustainable development goals aim to address these inequalities and improve the health of children around the world. These goals include targets for reducing child mortality, improving maternal health, and providing universal access to quality healthcare (United Nations, n.d.).

Child mortality rate, 2021
The share of newborns who die before reaching the age of five.

No data   0%   0.5%   1%   2%   5%   10%   20%   50%   100%
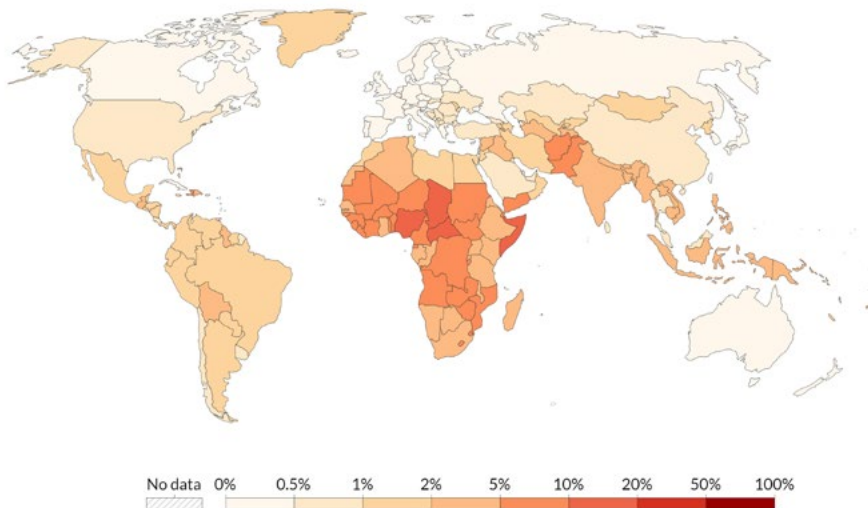
Source: United Nations, World Population Prospects (2022)
Note: This is the probability of a child born in a specific year or period dying before reaching the age of five, if subject to age-specific mortality rates of that period. This is given as the share of live births.

OurWorldInData.org/child-mortality/ • CC BY

Figure 1.1: Infant mortality rate around the world

1.1.2 Health in the 1st 1000 days of life

"The number of child deaths is that of 24 jumbo jet crashes, with only children on board, every single day."

- Hans Rosling (Our World in Data, 2021)
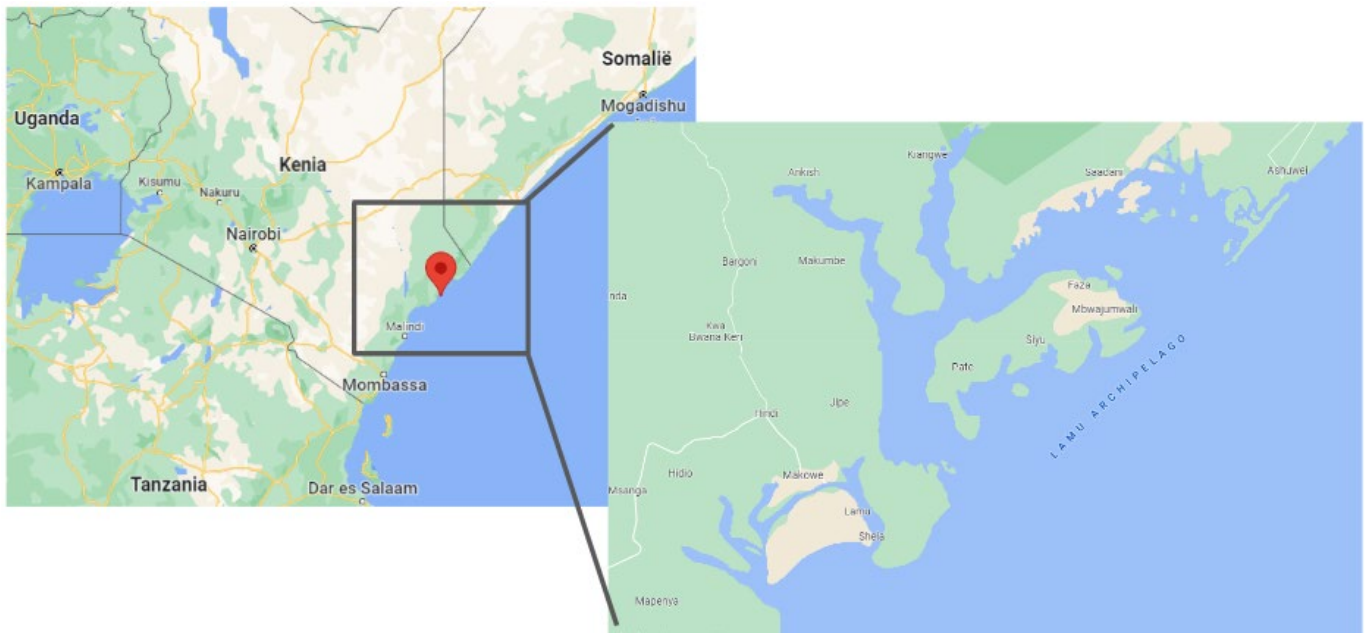
Figure 1.2: Lamu is located on the Northern coast of Kenya, close to the Somali border

The importance of the first 1000 days of life has been gaining recognition among researchers and policymakers in recent years. This time period, which starts from the beginning of pregnancy and continues until the child reaches the age of two, is considered crucial for the development and well-being of children. During this period, children undergo rapid growth and development, and are particularly sensitive to any negative influences or health risks. As a result, ensuring the child's health and well-being during this period can have a significant impact on their future development and overall health throughout their life (Walker et al., 2007).

In addition to the direct benefits for the child, there are also economic and social benefits for interventions that are focused on the first 1000 days, as it can be more cost-effective and can help to reduce inequality. For example, providing targeted support and services to disadvantaged youth during this time can help to prevent or mitigate the negative effects of poverty, poor nutrition, and other health risks, potentially improving their outcomes later in life. This can help to break the cycle of poverty and inequality, leading to better health and economic outcomes (Heckman, 2006).

1.1.3 Lamu, Kenya

This project focuses on the region of Lamu, which is the name of the county, archipelago and one of the islands in the archipelago all at once. The county of Lamu is located on the Northern coast of Kenya, close to the Somali border (see figure 1.2). It is known for its well-preserved Swahili settlement, Lamu Old Town, which is a UNESCO world heritage site. Tourism has played a significant role in the local economy, but the growth of this industry

has been hampered by infrastructure and security concerns. The majority of the roads in the area are in poor condition, some islands have no motorised traffic at all, and access to food and water is limited. (County Government of Lamu, n.d.).

The local population in Lamu is spread out across the mainland and various islands in the region. The limited infrastructure, geography of the area, and barriers to accessing health services, make it difficult for the locals to access quality health care. The local communities are exposed to a variety of health risks, including communicable and non-communicable diseases and poor nutrition. Cultural factors, such as the importance of rituals (Gearhart, 2013) and the constant mobility of some communities within the region, also pose challenges for health service providers trying to reach those in need. These challenges have also had a negative impact on child health in the region. In comparison to the national average, child health metrics in Lamu are significantly worse. For example, the under-five mortality rate is 62 in Lamu, compared to 44 nationally (Healthdata, 2020).

One out of every six people in the population is younger than five years old. It is anticipated that the population under five years old will increase in the coming decades based on the current demographics of the area. Action is therefore especially needed to address this, so that the growth in this age group will not put additional strain on the already limited health infrastructure in the region.

1.1.4 Healthcare in Lamu

The healthcare system in Lamu is challenged by the geography of the area, the underdeveloped

infrastructure, cultural factors and a shortage of supplies and personnel. As mentioned before, communities are spread out on various islands and the interior of the region, often far removed from hospitals where basic medical procedures can be carried out. To illustrate, figure 1.3 shows the locations of the most populous urban centres in Lamu and where the district hospitals are, which are the facilities where general healthcare procedures can

care facilities. Examples of this include telemedicine, where doctors and patients communicate remotely using video conferencing or phone calls, and the use of remote monitoring devices that allow patients to track and manage their health from home. This approach could be of use for communities in remote or underserved areas. Integration of technology in healthcare systems, especially in LMICs, can make healthcare more accessible and

"If you look at a village… like Kiunga, where if you have any complication, require a C-section or anything, and you're trying to come to the main hospital, it's about an 8-hour big boat ride, or you're hiring a speedboat, $300 for a one-way ticket,"

Safari Doctors (World Economic Forum, 2022)

be carried out. Looking at the map, it can be quickly observed that these facilities can be far away and hard to reach. Take Kiunga for example, located close to the Somali border, from where it is a long boat ride to the closest hospital.

available, given the limitations in funding and health worker availability. Mobile technologies, in particular, have shown promise in transforming healthcare systems in LMICs, offering increased connectivity to quickly communicate test results, remind patients of medication and vaccination appointments, and disseminate information on best practices during pregnancy (McKinsey, 2021; World Economic Forum, 2015).

1.1.6 Opportunities for technology and innovation

Technologies and innovation have the potential to bridge the gap between communities and health-

1.2 Who is involved?

This project is part of Healthy Start, an initiative between the Delft University of Technology, Eras-
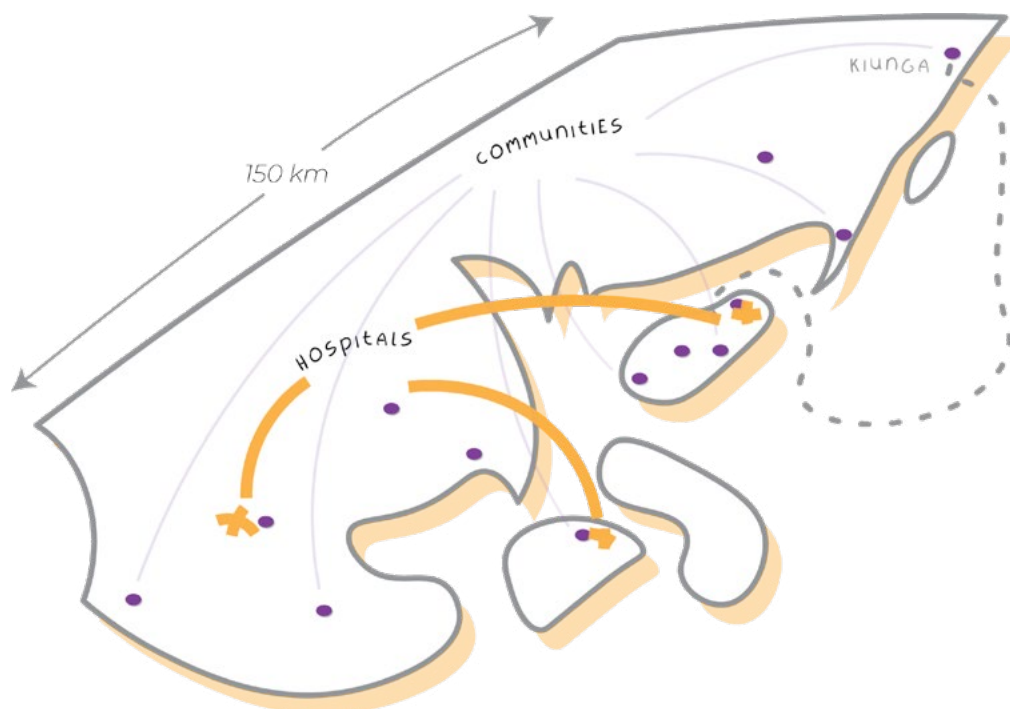
Figure 1.3: the location of the more populous "urban" centres in Lamu along with the location of the district hospitals where general procedures can be carried out

mus MC and the Erasmus Universiteit Rotterdam. Healthy Start has the mission of giving every child an equal starting position in life. Through collaboration between researchers, designers and organisations, it aims to tackle complex societal issues to improve the health of children around the world. The majority of the main players of the initiative are Dutch or based in the Netherlands, but there is an ambition to look across borders. By exploring the issue in several countries such as the Netherlands and Kenya, and therefore adopting both global and local perspectives, the initiative aims to learn how different contexts require different interventions to improve and can inform each other.

The collaborative partner of Healthy Start for the local perspective in Kenya is the Kenya Red Cross Society (KRCS). As an organisation, KRCS has the mission to alleviate human suffering through responding to humanitarian emergencies and implementing community driven programs to transform lives and enhance resilience. Their main activities are disaster management, health nutrition and social services, and organisational development, and they have an active presence in the Lamu region.

1.3 Purpose of this project

This project is of an explorative and pragmatic nature. It is explorative as this project helps Healthy Start by broadly identifying what problems are relevant in Lamu in the first 1000 days and exploring how interventions could be of benefit. It is pragmatic as the project tries to identify a non overly complex health challenge, which can be addressed by existing technologies and thus make a difference in the short term.

The purpose of this project is to explore how technology and innovation could contribute to a better healthy start for all children in communities in Lamu. This means that this graduation project will not focus on improving the local infrastructure, increasing the number of qualified doctors or building new hospitals (all of which could be beneficial but do not fit the scope of this project), but rather try to find new directions of innovation in which products and services could bridge the current gap between the communities and the healthcare system, see figure 1.4.

1.3.1 Initial project goal

"We want to make sure that every child in Lamu has a healthy start to life by empowering communities to ... using available technologies"
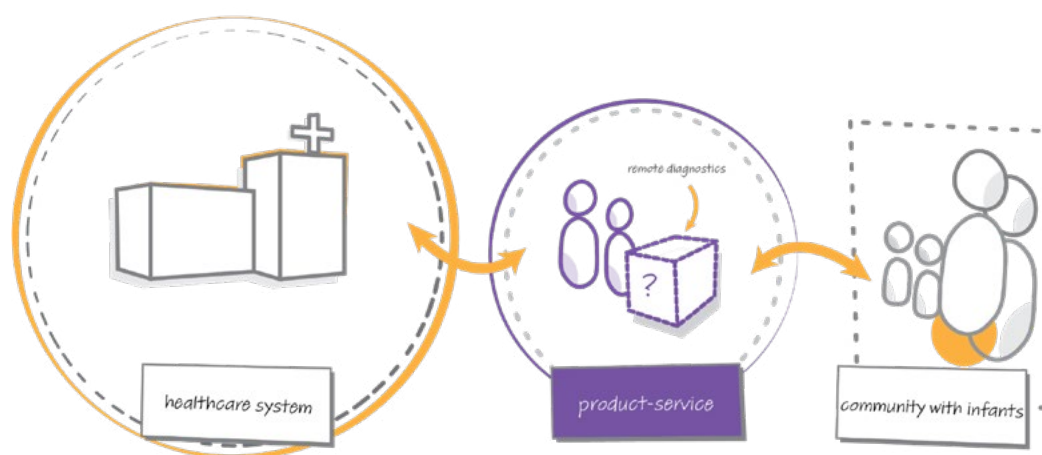
Figure 1.4: the purpose of this project is to explore how technology and innovation, through a product-service concept (or intervention), could bridge the gap between the healthcare system and the communities.

A common scene when walking around the streets of Lamu old town

Chapter 2: Approach

The previous chapter introduced the context and topic of this project. This chapter introduces the research questions that the project aims to answer and the approach that was taken to answer those research questions.

2.1 Main research questions and approach

The main research question of this project is as follows:

> *"How can we improve the healthy start to life in Lamu using available technologies within the local current context?"*

To answer this question, the main work of this project is build up in *three main sections: section two, section three and section four*, see figure 2.1. In total, there are four diverging and converging diamonds in these sections.

In the *second section*, a focus on a specific health challenge is found. It first explores which health problems are relevant in the first 1000 days in Lamu, therefore identifying the problem spaces. Next, for the health problems that are found it is explored whether the problem is not overly complex and has opportunities for technologies and innovation to make a difference. The final decision on which health challenge this project should focus is made together with experts from the KRCS, and the chosen health challenge is explored in depth. This is to answer *RQ1: Which health challenge is a local burden in the first 1000 days, is culturally relevant and offers opportunities for available technologies?*

The resulting health challenge focus was (un) healthy nutrition, which is used in the formulation of the next research questions for clarity.

The *third section* is made up of two diamonds. the first is to understand the current context of the chosen health challenge in Lamu. It explores the cultural makeup of the communities, the local context of nutrition, the lives of families and the healthcare system and its barriers. This is to answer *RQ2: What are the problems, needs and opportunities in the local current context around (un)healthy nutrition in the first 1000 days?*

The second diamond of this section aims to understand which tools and technologies are currently and could be used in Lamu that are relevant to the chosen health challenge. This answers *RQ3: Which available technologies are used in the context of (un)healthy nutrition and in Lamu communities?*

The *fourth section* builds on the context and technologies exploration done in the second and third phase. It combines the insights and looks at which areas of innovation are possible to transform the system. It develops and evaluates intervention scenarios. This is to answer *RQ4: How could a product-service-system (intervention) improve the healthy start to life in Lamu using available technologies within the local current context?*

A further description of the research questions and approach taken will be given at the start of each chapter in this report.
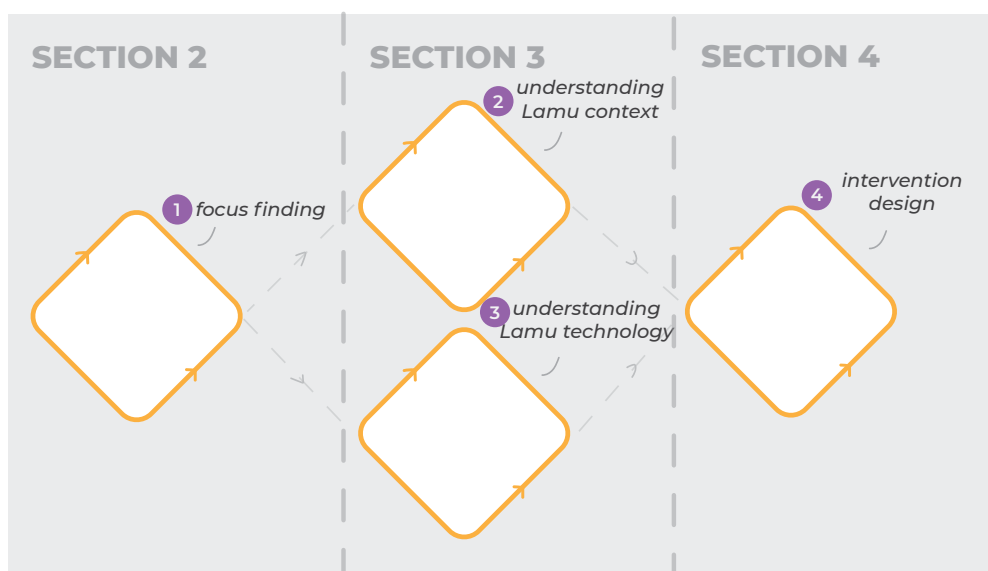
Figure 2.1: Overview of the four main phases of the design process

2.2 Project Methodology

An overview of the methodologies used during the phases of the project is presented below in figure 2.2. The outcome (the what) and the purpose of each part is defined as well.

2.2.1 How does the fieldwork influence the project?

A crucial part to the approach of the project was the fieldwork. An overview of the fieldwork activities is given in the next section. Fieldwork activities are marked orange in the methods and activities row of figure 2.2.

	SECTION 2		SECTION	
	1 *focus finding*		**2** *understanding Lamu context*	
Why? Objectives	What are relevant health challenges in the first 1000 days in Lamu? Which relevant health challenge offers opportunities for available techologies?		What are the relevant local cultural factors? What are the local problems and needs around nutrition and healthcare?	
When? Phase in the project				
How? Methods and activities	Literature research	Literature research Strategic session	Literature research Interviews Observations	Stakeholder mapping Insights structuring
What? Result	−Health challenges in first 1000 days map −Relevant health challenges for Lamu map	− Complexity and technological opportunities map − Health challenge chosen − Deep dive (un)healthy nutrition	−Interviews documentation −Observation frameworks	− Stakeholder map Patient journey − Accessibility of healthcare map − Cultural factors defined

Figure 2.2: Overview of the objectives, methods and activities, and results per phase of the design appraoch

3

understanding
3 *Lamu technology*

What tools and technologies could be used locally in the context of nutrition? What technologies are already used in the local context?

Literature research
Interviews
Observations

fieldwork activities

- Technologies for nutrition and context explored
- Observation frameworks

Insights structuring

- Structured insights
- Available and suitable technologies defined

SECTION 4

intervention
4 *concepting*

How could an intervention that uses available technologies and is acceptable for the local culture improve local nutritional outcomes in the first 1000 days?
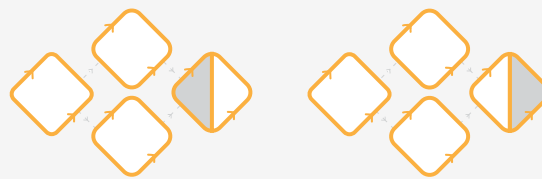
Ideation
Co-creation
Generative sessions
Visualization

- Identified opportunities
- Intervention scenario's

Evaluation forms
DesFeaVia evaluation
Reflection

- Evaluated intervention scenarios

2.3 Fieldwork overview

An important part in answering the formulated research questions was four and a half weeks of fieldwork in Lamu. The goal was to understand Lamu from a cultural, healthcare and technological perspective.

In total, 17 stakeholders were interviewed in a semi-structured approach: 11 experts (from NGOs, hospitals and facilities, and the public health office), two CHVs and four with caregivers who had recently had a child. Three health care facilities and two communities were observed.

The fieldwork also played a role in the development of the intervention concepts. A session was held with two CHVs to evaluate and co-create some of the specifics of the scenarios.

Details of the fieldwork research questions, activities and frameworks can be found in appendix A.1.
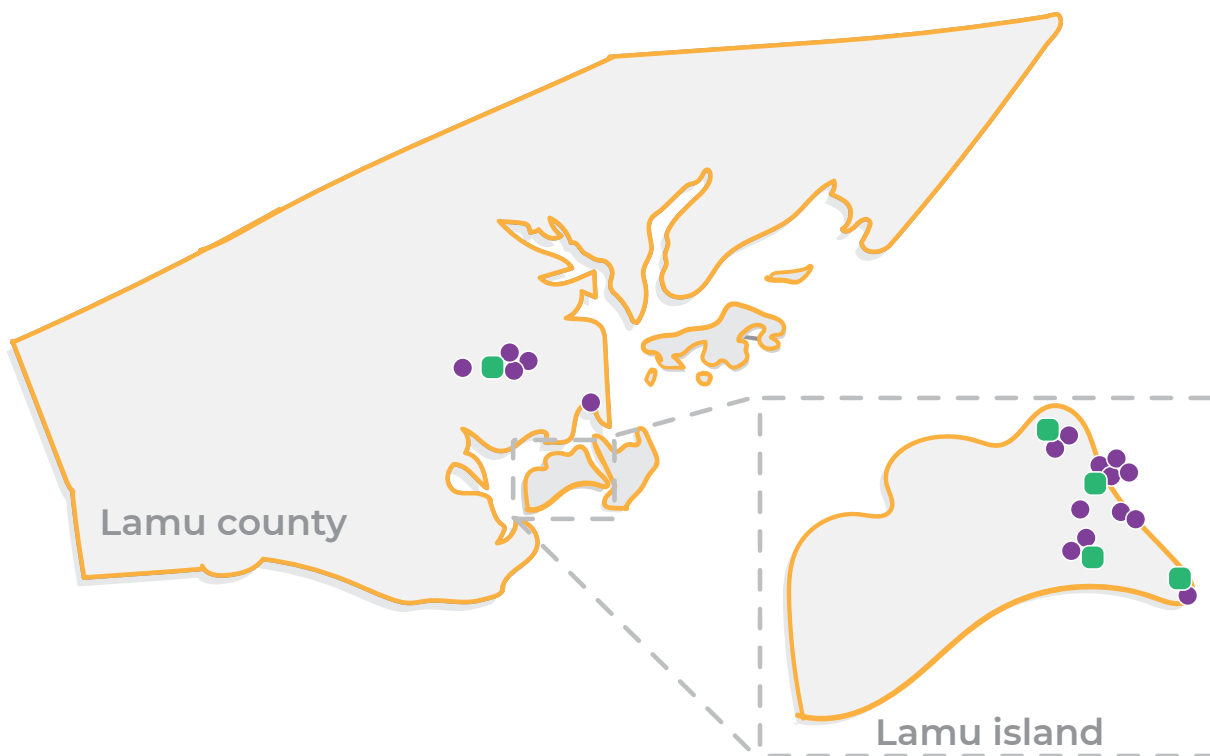
Figure 2.3: overview of the locations visited during the fieldwork to conduct interviews (purple circles) and observations (green circles)

Waiting for a motorcycle to drive me back from doing interviews at a local dispensary

SECTION 2

// Focus finding //

Chapter 3: Finding a focus
Chapter 4: Understanding (un)healthy nutrition in the first 1000 days

In this section, a health challenge that will be the focus for the project is found, after which the chosen health challenge is understood in depth.

Chapter 3: Finding a focus

This chapter describes how the project found a focus health challenges that are present in the first 1000 days to find one that was especially relevant for this project to focus on.

3.1 Approach

The aim at the start of this project was broad: to address inequality in health for children during their first 1000 days of life. As the project aims to identify areas of opportunities for interventions, it was necessary to narrow the focus of the project to a specific health challenge.

A health challenge needed to be found that fit several criteria. As the project is of a pragmatic nature, these criteria were set up so that the project would focus on something that could be addressed through an intervention that uses technology. The first criteria is that the health challenge needs to be relevant in the first 1000 days in Lamu. Second, it needed to be culturally relevant, that is to say that the problem was recognized by the local communities, as otherwise it would be hard to explore the challenge during the fieldwork. Third, the challenge needs to present itself with opportunities for technology to make a difference. This is summarised in figure 3.1. In order to find this suitable challenge, a first map of all health risks and problems in the first 1000 days was made, which was narrowed down based on factors such as feasibility and scope.

From this, a shortlist of common, relevant, and feasible health challenges was selected to focus on. Finally, a mapping was conducted to identify technological opportunities for addressing each challenge, and a strategic session with members of KRCS was held to determine the final focus of the project.

3.1.1 Chapter research questions

The research questions that this chapter aim to answer are:

- Which health challenge is a local burden in the first 1000 days, is culturally accepted and offers opportunities for available technologies?

   - What are the relevant health challenges in the first 1000 days in Lamu?

   - Which relevant health challenge offers promising directions for new interventions?

relevant health problem

technological opportunity

culturally relevant

Suitable health challenge focus
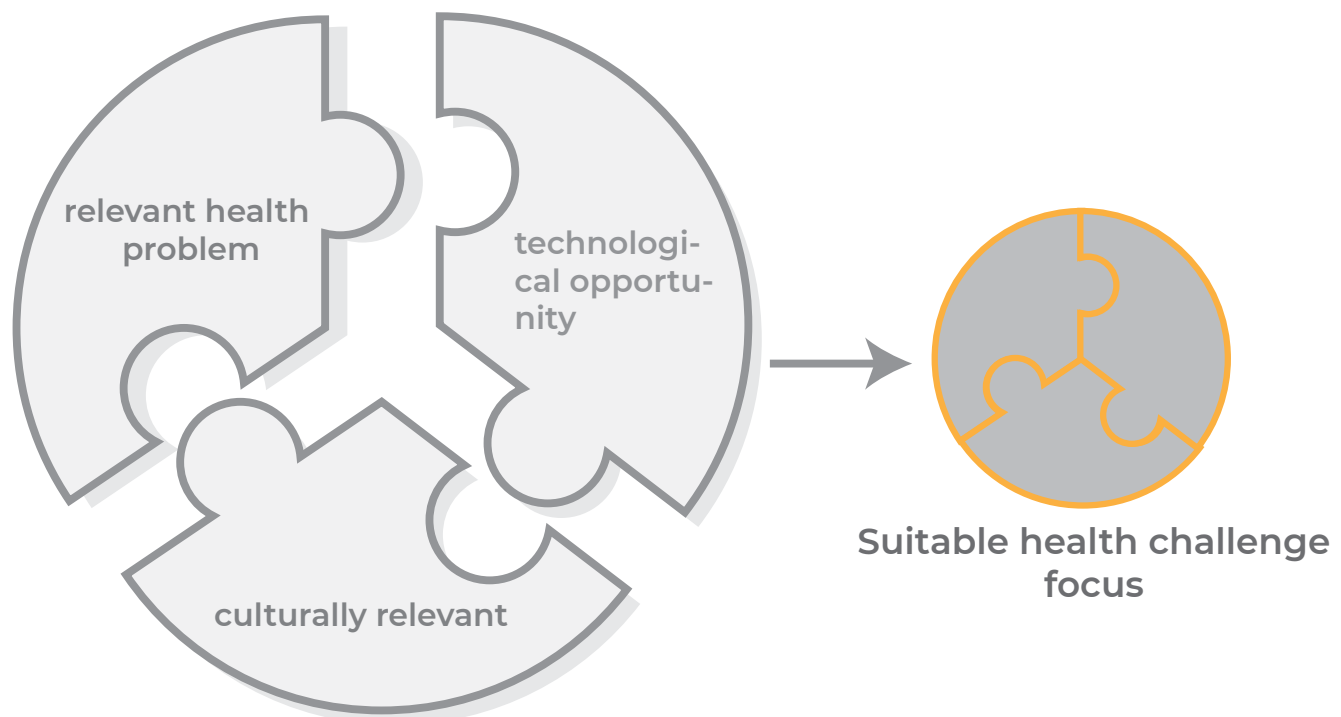
Figure 3.1: the health challenge that could be focused on needed to be a relevant health problem locally, have opportunities for available technologies and be culturally relevant.

Figure 3.2

	Pregnancy (Conception → Birth)	**Infancy and early childhood** (Birth → 1 year old → 2 years old)
Healthcare moments	antenatal care (ANC) visits	delivery by skilled birth attendant; postpartum care; counseling; vaccinations; postnatal visits; growth monitoring
Health risks *(indirect influence)*	overnutrition; undernutrition; pollution (air, water and soil); **improper nutrition**; **environmental factors**; bacterial; **infections**; micronutrient deficiencies; lead; pesticides; viral; parasitic; high blood pressure; diabetes; stress; trauma; obesity; **medical**; thyroid disorders; **mental health**; depression; smoking; anxiety; **substance use**; alcohol and drugs	lack of postnatal healthcare services; lack of preventative health care services; non-exclusive breastfeeding; **inaccessible healthcare**; **improper nutrition**; barriers to healthcare; insecure nutrition and water; over/undernourishment; stress; **mental health**; lack of bonding with parents; **low socioeco-nomic position**; **lack of proper hygiene**
Health problems *(direct influence)*	physical trauma; placental problems	low birthweight; hand, foot and mouth disease; congenital anomalies; hemolytic disease; respiratory infections; **asthma**; **neonatal disorders**; gastrointestinal infections; diarrheal diseases; rashes; birth asphyxia; neonatal infections; **infectious**; typhoid; preterm brith; birth defects; dengue fever; urinary tract infections; wasting; tuberculosis; parasitical infections; meningitis; **undernutrition**; stunting; micro-nutrient deficiencies

Figure 3.2: general health risks, problems and important moments of health care in the first 1000 days of life

3.2 Health challenges for young children in Lamu

3.2.1 Health challenges in the first 1000 days of life in general

The first 1000 days of life are a critical period for a child's health and development. This time starts from the moment of conception and continues until the child reaches approximately two years of age. During this period, a wide range of factors can affect a child's health. During pregnancy factors such as the mother's diet, physical health, and stress levels during pregnancy all affect the development of the soon-to-be newborn. They can influence the timing and details of the child's birth, such as the birthweight and any complications that may occur during delivery.

After the child is born, they are particularly vulnerable to health risks such as communicable and non-communicable diseases, undernourishment, and limited bonding and interaction with the parents. All of these factors can have a significant impact on the child's healthy development during the first 1000 days of life. In the first six months, exclusive breastfeeding is especially important for a healthy development, after which proper additional feeding is needed for further growth.

So, many factors can influence the healthy development of a child, they can be directly related to the child in the form of health problems, or can be indirectly related, through health risks. In the three stages of pregnancy, infancy and early childhood some factors might be of more importance. Figure 3.2 gives an overview of general health risks, problems and important moments of health care in the first 1000 days of life.

3.2.2 Narrowing down to 9 health challenges

A first narrowing is made by deciding that the focus of this project was on health risks and challenges in the first 1000 days of life that are directly related to the child, such as undernourishment, communicable and non-communicable diseases. Lifestyle, medical conditions, substance abuse, and environmental factors, while certainly important, were not considered for the remainder as they are not as directly impactful on the health and development of the child during the first 1000 days of life.

After taking out the indirect risks, several challenges remained. These included infectious diseases, undernutrition, neonatal disorders, and chronic conditions such as asthma that could be suitable for this project to focus on. Through communication with the KRCS, nine of these were chosen for further exploration in the next steps.

Next, the remaining nine diseases were investigated in more detail through desk research and a literature study. For each disease, it was established whether it was especially relevant in the first 1000 days, if the disease was a burden in Lamu and finally, if the disease was known to be especially difficult to do something about.Is it notoriously complex to prevent/diagnose/treat?. This process is described in the flowchart in figure xx. This process would be followed by looking for obvious opportunities for technology and innovation for the resulting selection of diseases.

0   *All health issues*

1   *Direct health problems*

IDENTIFYING RELEVANT PROBLEM SPACES

2   *Relevant in first thousand days*

3   *Burden in Lamu*

4   *Not overly complex*

MATCHING SOLUTIONS SPACES

5   *Obvious opportunities for technology*

EVALUATING AND CHOOSING FOCUS

6   *Strategic Session KRCS*
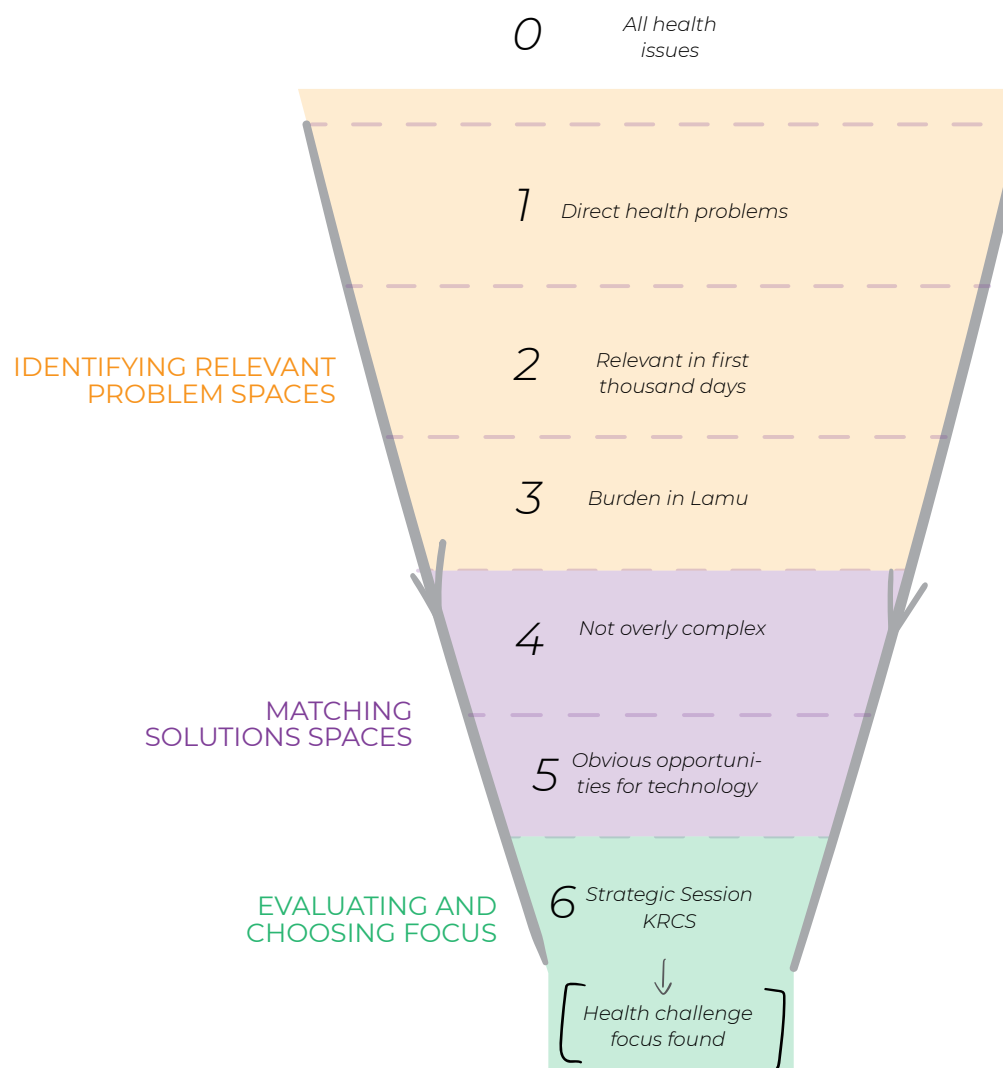
Health challenge focus found

Figure 3.3: the steps taken to find a health challenge focus

3.2.3 Finding relevant problem spaces - Influence and relevance for 9 relevant health challenges in the first 1000 days in Lamu

Pneumonia

Pneumonia is an acute infection of the lower respiratory system. When a child is infected, the alveoli that make up the lungs fill with pus and fluid. This makes it painful to breathe and lowers the amount of oxygen intake. In severe cases, this can be deadly (World Health Organization, 2021b).

Influence on health in first 1000 days

Pneumonia is the deadliest infectious disease in the first two years of life, with more than 200 000 newborns dying from the disease (Unicef, n.d.-a) (World Health Organization, 2021b) . Pneumonia is especially deadly for infants, and accounts for a big part of neonatal mortality (Ferdous et al., 2018) (Duke, 2005). Global childhood deaths from pneumonia are decreasing much more slowly than from other major killers (Watkins & Sridhar, 2018).

Global and local burden

Pneumonia is the largest cause of death for children around the world when it comes to infections, accounting for 22% of all deaths up until the age of 5 (World Health Organization, 2021b). In Lamu, it is also a major cause of mortality, only coming second to neonatal disorders (Healthdata, 2020).

Stunted Growth

Stunted growth is when children experience impaired growth and development. This is caused by chronic poor nutrition, recurrent infections or chronic diseases that affect nutrient intake and inadequate psychosocial stimulation (World Health Organization, 2015). Stunting at an early age has dramatic consequences on the later development in life (Walker et al., 2005).

Influence on health in first 1000 days

Stunting usually develops in the first 1000 days (Kuklina et al., 2006) and has immediate and long-term consequences. Importantly, these consequences are largely irreversible (Georgiadis & Penny, 2017). Some of these consequences can be higher rates of mortality, reduced cognitive and physical development and an increased risk of nutrition related chronic disease (Black et al., 2013)

Global and local burden

Nationwide in Kenya, a quarter of all children suffer from stunted growth (Martin et al., 2020; Unicef, n.d.-b), compared to one in five globally (World Health Organization, 2015).

HIV

Human immunodeficiency virus (HIV) is a virus that weakens the immune system against other infections and several types of cancer. Infected people in the first stage often do not experience symptoms or experience mild flu-like symptoms. HIV transitions to immunodeficiency syndrome (AIDS) in the most advanced stage, where long term health problems such as infections or cancers are present. Symptoms differ per stage of infection. HIV can be transmitted from mother to baby throughout pregnancy, childbirth and during breastfeeding. It can be prevented through HIV medicines (World Health Organization, n.d.-c).

Influence on health in first 1000 days

HIV during the first 1000 days of life can have severe effects on infant health. Studies have shown that infants born to HIV-positive mothers are at twice the risk of hospitalisation and over four times at risk of death compared to uninfected infants (Venkatesh et al., 2011). Even if the infant does not acquire the infection itself, the risk for mortality is still high (Kurewa et al., 2010).

Global and local burden

Globally, 38.4 million people are living with HIV, and 650 000 people died from it in 2021 (World Health Organization, n.d.-b). Africa is the region with the highest incidence of HIV, nearly 1 in 25 people are infected. In Lamu, HIV is the third leading cause of death across all age groups.

Neonatal Disorders

Neonatal disorders is the collection of several health complications that can occur during and just after birth. Among the leading causes of death in the neonatal period are preterm birth, intrapartum related complications such as birth asphyxia (not breathing at birth), and birth defects (World Health Organization, 2022b).

Influence on health in first 1000 days

Neonatal orders are by definition present in the first 28 days of life, so it influences health in the first stages of life.

Global and local burden

The first month of life is fatal for 2.4 million newborns around the world. The global under 5 mortality is declining more rapidly than neonatal mortality, which makes neonatal mortality now responsible for half of all under 5 related deaths worldwide (World Health Organization, 2022b). Neonatal disorders are the leading cause of death in the Lamu region (Healthdata, 2020).

Dengue Fever

Dengue fever is a viral disease that gets transmitted via mosquito bites. It causes a wide range of symptoms. For some people, the infection is mild with no obvious symptoms. Others experience severe symptoms that closely resemble flu. In some cases, severe dengue develops in which complications such as organ impairment and severe bleeding can occur. There are four distinct types of dengue virus, which are known as DENV-1 through to DENV 4, all with distinct outbreak patterns. Infections mostly happen during the day. Infections happen around the year, with large cyclical outbreaks (World Health Organization, 2022a; Yung et al., 2015).

Influence on health in first 1000 days

Infants are at a higher risk of developing severe dengue and dying from it compared to older children (Jain & Chaturvedi, 2010) . Infants are most at risk for severe dengue disease, and the majority of dengue cases are children under 15 years of age (Verhagen & de Groot, 2014). Severe dengue has a mortality rate of 1% if clinical care is provided, it can rise up to 20% without it (Africa CDC, n.d.).

Global and local burden

Dengue is endemic in large parts of the globe, such as Africa, south-East Asia and the Americas. Parts of Europe are seeing more infections as well. In general, the incidence of infections is rising. The number of reported cases, in part due to more emphasis on the need of reporting in cases, has increased by a factor of 8 over the last two decades. The number of infections has increased as well in Kenya over the last years (World Health Organization, 2022a). but dengue in sub-Saharan countries is often underreported or mischaracterized (Were, 2012), making accurate estimates of the disease burden difficult. Dengue in Lamu is not in the top ten causes of death.

Malaria

Malaria is a disease caused by a certain group of parasites that gets transmitted through mosquito bites. Upon infection, people gradually exhibit worsening symptoms from fever, headache and chills to severe disease and death if left untreated. The deadliest malaria parasite is most common in the African region. Children under five are at a bigger risk of severe symptoms if they are infected.

Influence on health in first 1000 days

Studies have concluded that malaria is not particularly common among infants, as the first stages of life benefit protection from maternal immunity. It has been shown that malaria in this stage of life could lead to anaemia if untreated (D'Alessandro et al., 2012). Malaria is therefore not especially relevant in the first 1000 days.

Global and local burden

Worldwide yearly, there are more than 200 million cases with more than 600 000 deaths. 93% of deaths happen in sub-Saharan Africa. In Kenya, there are an estimated 3.5 million cases with more than 10 000 deaths per year, with people in the West of the country especially at risk. Lamu is therefore not a region especially at risk for Malaria. Prevention, diagnostics and treatments are available and effective.

Diarrhoea

Diarrhoea is when the stool becomes runny and watery, usually due to an infection in the intestines. It can dehydrate the body with fatal results. It can be caused by bacteria, viruses or parasites. There is a differentiation between acute watery diarrhoea, acute bloody diarrhoea, and persistent diarrhoea (World Health Organization, 2017).

Influence on health in first 1000 days

Diarrhoea is especially deadly in young children, with the incidence the highest in the first two years of life (Unicef & World Health Organization, n.d.).

Global and local burden

Diarrhoea is the second cause of child mortality around the world, killing more than half a million children under five a year. It is also the leading cause of malnutrition for children. (World Health Organization, 2017). It is the 7th leading cause of death for all age groups in Lamu (Healthdata, 2020).

Cholera

Cholera is a disease that can cause severe acute watery diarrhoea. It affects both adults and children, but most people do not develop symptoms. A small minority of those infected will be affected by it through severe acute watery diarrhoea and dehydration, which can be deadly if left untreated. It is caused by ingesting water or foods that are contaminated with the bacteria (World Health Organization, 2022c).

Influence on health in first 1000 days

Children under five is the age group that are most frequently and most severely affected by cholera, with about half of the cases and deaths occurring in this age group (Ali et al., 2012)

Global and local burden

Globally, Cholera is estimated to be responsible for 91,000 deaths per year, out of 2.8 million cases (Ali et al., 2012). Case fatality for cholera is higher in rural areas and the burden has been increasing (Williams & Berkley, 2018). Cholera, as part of diarrheal diseases, is a substantial burden in Lamu (Healthdata, 2020).

Asthma

Asthma is a long-term chronic disease that causes the air passages in the lungs to become narrow due to inflammation and tightening of the muscles in that area. It affects both children and adults and causes symptoms such as wheezing, coughing and shortness of breath. These symptoms are not constant, but show up at particular times such as at night or during exercise. Asthma itself is caused by a variety of factors, such as exposure to air pollution, genetics and allergic conditions. It is difficult to identify the specific cause for asthma.

Influence on health in first 1000 days

Hospitalizations due to asthma are particularly common in children under 5 (Ferrante & La Grutta, 2018). Development of asthma in the first years of life can occur due to environmental factors, such as air pollution, and genetic factors (Nascimento et al., 2017) , Once asthma has developed, it is a chronic condition for the rest of life that influences the daily lives of children and caregivers alike, as it affects physical and social activities (Ferrante & La Grutta, 2018).

Global and local burden

Asthma affects more than 250 million people and caused 455 000 deaths in 2019 (Ferrante & La Grutta, 2018). The disease can impair healthy living without fatal consequences. It is especially underdiagnosed in Low- and Middle Income Countries, such as Kenya (World Health Organization, 2022d). The prevalence of asthma has increased in the last two decades, especially in LMICs (Ferrante & La Grutta, 2018)

3.2.4 Remaining health challenges

After the selection procedure as described above, seven health challenges remained that would provide a relevant problem space for this project to focus on; pneumonia, stunted growth, HIV, neo-natal disorders , dengue fever diarrhoea/cholera and asthma. Since cholera is a diarrhoeal disease, cholera and diarrhoea are grouped together for the next step.

A visual that summarises the worked out process that the first four steps of the flow-chart describes is found in figure 3.4

	Relevant in first 1000 days	Relevant local disease burden
Pneumonia		
Stunted growth		
Diarrhoea		
Neonatal disorders		
HIV		
Dengue fever		
Asthma		
Malaria		
Cholera		

Figure 3.4: visual summarising the selection procedure based on local relevance and relevance in the first 1000 days, from which it can be seen that only malaria was not particularly relevant

3.3 Estimating solution spaces - complexity and room for technological opportunities for the remaining health challenges

To decide on a focus for this project, we will look at the obvious opportunities for each disease that was left after the previous selection. By finding matches of relevant health problems in Lamu in the first 1000 days with obvious opportunities for available technologies, we can identify the health problems that offer the most potential for new interventions to start making a difference.

To get an idea of the complexity and technological opportunities for each health challenge, we explore each health challenge along the three main stages of disease; prevention, diagnosis, treatment and recovery.

3.3.1 Complexity and technological opportunities of remaining health challenges

Pneumonia

Complexity for interventions

The disease is largely preventable through vaccination and early diagnosis (Our World in Data, 2019), which would be affordable (Watkins & Sridhar, 2018). The treatment of pneumonia typically involves the use of antibiotics, but it can be difficult to differentiate between a viral or bacterial infection. If the cause is bacterial, determining the type of bacteria causing the infection and choosing the appropriate antibiotic is further challenging. Studies have shown that the cause of pneumonia could not be identified in a significant proportion of cases (Jadavji et al., 1997).

Technological opportunities

For prevention of pneumonia, technology could assist in sending timely reminders for vaccinations or assist in the taking of medicine. A similar project has already been done but it is unclear whether it is still active (Kahenda, 2022).

For diagnostic technologies of infant pneumonia, products such as pulse oximetry, and respiratory rate counters, could assist in earlier referral to health centres or give insight to mobile health teams of which children to attend to (King et al., 2019). Pulse oximeters are, however, a challenge for young children and can be expensive and respiratory rate counters can be unreliable (King et al., 2019; McCollum et al., 2019). Diagnosis is not

straightforward, but by combining various aspects and potentially using machine learning tools, a good indication can be made (Amirav & Lavie, 2019) Furthermore, these diagnostics could be used to monitor progress of treatment as well as during recovery.

For the treatment of pneumonia, the type of treatment depends on the cause of pneumonia, for which the diagnostics as described above are needed. Technology could play a role in the access to connect dispensaries to medicines.

Stunted growth

Complexity for interventions

Stunting in young children can be diagnosed by measuring their height-for-age and determining if it is more than two standard deviations below the WHO Child Growth Standards median (World Health Organization, 2015). Due to the diverse causes of stunting, treatment can be complex, and interventions are needed on a systemic level such as community programs that focus on improving access to proper sanitation, clean water, diversified foods, poverty reduction, education on child feeding and infection prevention, and accessible health services (World Health Organization, 2015).

Technological opportunities

In general, single interventions are potentially not effective for affecting stunted growth, as a systemic approach is required (World Health Organization, 2014b).

For prevention, technology could assist in the dissemination of information around the importance of nutrition during pregnancy and the early stages of life and hygiene practices.

Because the diagnosis of stunting happens through measuring height and checking the resulting height-for-age z score (World Health Organization, 2015), it can be done through simple technologies and tools that are readily available. Technology could help in measuring the length of young children. Growth monitoring in the first stages of life could be done to help track growth and signal problems in an early stage (Hijrawati et al., 2021).

Treatment is based on the cause, which is complex and requires health expertise. There is no direct obvious technology that can enable this. There are no direct obvious opportunities for the treatment of stunting, although the progress of

treatment and recovery could be tracked using the same tools as the diagnosis.

HIV

Complexity for interventions

To prevent and treat HIV in infants, early diagnosis is crucial through serological testing in the first weeks of life and treating them with antiretroviral therapy (ART). It is important to establish the HIV status of all infants and children as early as possible, through maternal testing, health card check or rapid antibody test, and then conduct a viral testing (e.g. PCR) for infants known to be HIV-exposed or at the earliest possible opportunity for those seen after 4-6 weeks of age. Early ART treatment can improve survival rates in infants with HIV (Clinical Info HIV, n.d.; World Health Organization, 2010).

Technological opportunities

For HIV, technology could play a role in the dissemination of information that is necessary for prevention.

For diagnosis, various forms of laboratory and point-of-care serological testing are increasingly available that lead to early detection for HIV infected infants, which is crucial to prevent significant health problems later on (UNAIDS, 2016; Unitaid, 2015)

No direct opportunities are there for the treatment of HIV (antiretroviral therapy (ART). Continuing forms of testing to monitor progress is needed to know whether the medicines are working, or if other steps need to be taken. As HIV cannot be cured (but can be controlled), recovery doesn't present obvious opportunities.

Neonatal disorders

Complexity for interventions

Single interventions are unlikely to make a big impact (Goldenberg et al., 2018). To target neonatal disorders, improving overall pregnant related care quality in the health system is necessary. Single interventions have not shown to achieve substantial reductions in deaths from neonatal disorders (Lassi et al., 2015). That being said, the most effective interventions include antenatal-corticosteroids, exclusive breastfeeding, cord care, kangaroo care, bednets, and administering vitamin A supplements (Goldenberg & McClure, 2015).

Technological opportunities

As neonatal disorders are shown to require a systemic upgrade, there are no direct available technological opportunities that could make a difference.

Dengue fever

Complexity for interventions

There is no specific treatment for dengue fever, and patients should rest, stay hydrated and seek medical advice if the dengue gets severe. It can be prevented by personal protection against mosquito bites, prevention of mosquito breeding, community engagement and active mosquito surveillance. Several methods can be used for the diagnosis of dengue, such as virus isolation and serological testing (World Health Organization, 2022a).

Technological opportunities

For dengue, technology could play a major role in predicting outbreaks and using the data to warn communities in an early stage to aid prevention efforts (Herbuela et al., 2021; Pley et al., 2021).

 Normal diagnosis of dengue through laboratory testing takes time and needs facilities which are generally unavailable in LMICs. Rapid tests are available but less accurate. which means they could be used to give an indication of an outbreak (World Health Organization, 2009). These could be especially relevant in LMICs (Kabir et al., 2021).

As there is no specific treatment for dengue except to rest, there are no obvious technological opportunities, and the same goes for recovery.

Diarrhoea and cholera

Complexity for interventions

Diagnosing the cause of diarrhoea is typically done through a stool sample that can be tested in a laboratory to identify the specific pathogen causing the diarrhoea. A lack of laboratory capacity in LMIC settings can limit the ability to diagnose and treat diarrhoea effectively (Mokomane et al., 2018). It can be prevented by implementing water, sanitation and hygiene (WASH) programs which aim to interrupt the transmission of diarrhoea-causing pathogens and promoting breastfeeding. In addition, vaccines can help reduce the incidence of diarrhoea and focusing on reducing risk factors such as undernutrition and low maternal education can help. The treatment of acute diarrhoea in children in resource-limited settings typically involves treatment of dehydration with oral rehydration therapy,

providing adequate nutritional support, and the provision of oral zinc therapy (Mokomane et al., 2018)

Cholera is usually diagnosed based on symptoms such as watery diarrhoea and severe thirst. Rapid tests for cholera are becoming commercially available, but they might not be suited for areas where cholera is common, such as often in LMICs. Confirming the diagnosis requires a laboratory test on a stool sample. The main treatment for cholera is replacing lost fluids and electrolytes. Antibiotics might also help reduce the duration of the illness. (Nato et al., 2003; Ricci et al., 2006).

Technological opportunities

For prevention, technology could be used to support hygiene and safe water practices, as well as be used to inform vaccination campaigns.

Since diagnosis is dependent on laboratory testing, and since this availability is typically limited in LMIC's, there are no obvious technological opportunities.

Technology could assist in prevention and treatment of dehydration with ORT, and be used to inform how much and how long treatment is necessary. Technology could assist health workers in reminding them for which clinical signs to check during recovery.

Asthma

Complexity for interventions

Diagnosis and treatment in young children is difficult, as the primary causes may be caused by other diseases and standard diagnostic tests and treatments are not suitable for children under 5 (Mayo Clinic, n.d.). Asthma might therefore not be particularly suitable to focus on.

Technological opportunities

Since diagnosis and treatment of asthma is difficult, there are no obvious available technological opportunities here.

3.4 Matching problem and solution space

Looking back at the health problems, two stood out that were relevant and that offered technological opportunities for tools to make a difference; stunted growth and pneumonia. Almost all diseases offer opportunities for increasing awareness and knowledge through technology, as well as connecting facilities to communities for treatment delivery. Stunted growth offers significant opportunities as the diagnosis is done through simple anthropometric measurements. The simplicity of these diagnostic tools could open up new directions for innovation. Pneumonia has similar "straightforward" diagnostics, albeit slightly more complex.
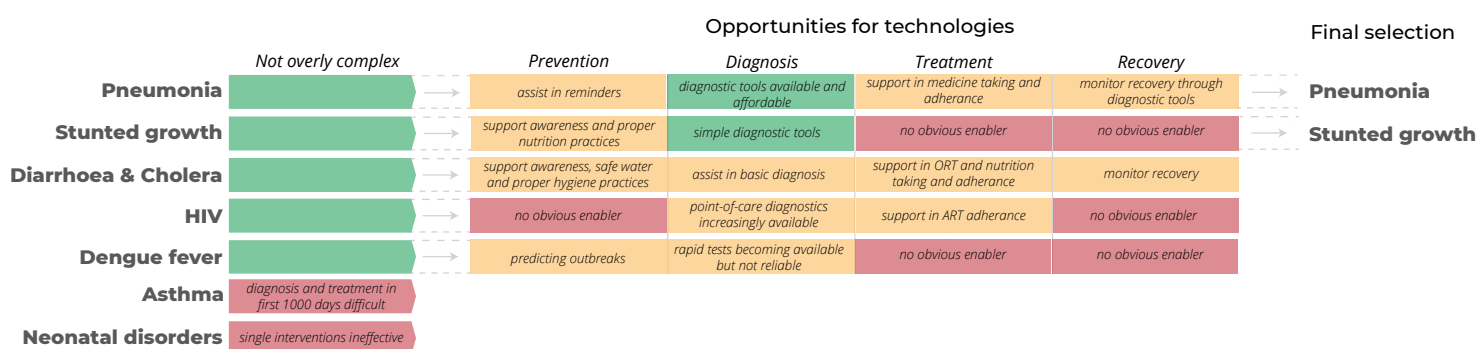

Figure 3.4: Summary the second part of the selection procedure, with first estimating the complexity for interventions per disease and exploring the obvious technological opportunities along the healthcare pathway for those that remained.

3.5 Session with KRCS to decide on final focus

To find the final focus between stunted growth and pneumonia, a session was held with the KRCS. As they are the experts of the context and would facilitate the fieldwork, it was essential to make the final scoping together. In this way, we would be sure to design for an important health issue, as was found in the previous research, but also one that was culturally relevant, for which the insights from the local experts in this session was essential. To have a rich discussion from multiple perspectives, it was important to have members of different roles present iIn the session from KRCS. To that end, a community manager, a doctor and an innovation coordinator from KRCS were present.

"If someone has been stunted they also have a larger risk of dying from pneumonia, so it starts with nutrition. If we can prevent stunting it would make a big difference." - Doctor at KRCS Lamu Rehabilitation Centre.

The session resulted in a final focus on stunted growth. It was a relevant problem that up until now had not been paid much attention to and that formed the basis for more health issues that were in the area. It offered opportunities for the local makerspace due to the relatively simple technology involved in diagnosis, and was deemed culturally relevant.

In a further discussion around stunted growth, it was suggested to broaden the scope to undernutrition. This would include other forms of nutrition problems such as wasting and micronutrient deficiencies that are a common problem in the Lamu region.

Finally, the health problem was reframed to healthy nutrition. This was because it was mentioned by the local experts of KRCS that undernutrition could be a sensitive topic. The reframing of the scope to a positive approach where the perspective would be taken of the healthy child rather than the undernourished child would be better suited to communicate the project to local stakeholders during the fieldwork. Furthermore, the positive approach better fits with the vision of Healthy Start, as they also take the healthy situation as the viewpoint.

3.5.1 Specified project goal

Thus, the goal of this project evolved from generally improving the health of young children in Lamu to:

"We want to make sure every young child in Lamu has healthy nutrition by... using available technologies"

Figure 3.5: Screenshot of post-its that were placed during the session to decide on a focus with local experts from the KRCS

3.5 Chapter conclusions

This chapter found a focus on a health challenge that would be suitable for the rest of the project to focus on. It achieved this through finding health challenges that were at the same time locally relevant and that presented itself with opportunities for available technologies, and deciding on the final focus for the project together with local experts from the KRSC.

Key takeaways for interventions

Requirements:

- Intervention should make use of available and affordable technologies   *Feasibility*

- Interventions should be framed from a positive perspective, such as framing the health challenge in the form of "healthy nutrition", as this generates acceptability from stakeholders   *Viability*

Opportunities:

- Interventions could focus on promoting nutritional outcomes in the first 1000 days in Lamu communities   *Desirability*

- Interventions could make use of the simple diagnostics for undernutrition   *Feasibility*

"Prevention is better than cure" billboard with carts that are used for transport

Chapter 4: Understanding (un)healthy nutrition in the first 1000 days

A health challenge has been chosen in the previous chapter, (un)healthy nutrition. In this chapter we dive deep into the chosen health challenge, to understand what it is and what can be done to improve on it.

4.1 Approach

The chapter focuses on gaining a deeper understanding of (un)healthy nutrition and the local healthcare system. The approach used is the WWWWWH framework, which involves researching the what, who, where, when, why, and how aspects of the health challenge. The research is conducted primarily through literature research.

4.1.1 Chapter research questions

The main research questions that this chapter aims to answer are:

- How can nutritional outcomes in the first 1000 days be improved?

- What are the causes, effects and burden of undernutrition in the first 1000 days?

- How can undernutrition be prevented, diagnosed and treated in the first 1000 days?

4.2 Understanding the medical background

4.2.1 Defining (un)healthy nutrition

Unhealthy nutrition can manifest itself in two sides of an unbalanced nutrition. An overconsumption of nutrients can cause obesity. A deficit in nutrition can cause undernutrition, which presents itself in several forms (Black et al., 2013). Even though obesity is increasingly an issue in Lamu, as mentioned by members of KRCS, for now we will focus on the different forms of undernutrition as they are more common, especially for remote and underserved communities.

Undernutrition manifests itself in three broad forms; wasting, stunting and micronutrient deficiencies. A fourth form, underweight, can be due to wasting, stunting or both (World Health Organization, 2021a). For young children, undernutrition can negatively affect growth, development and other

relevant outcomes (Mehta et al., 2013).

Wasting is defined as low weight-for-height. This usually comes from acute and rapid weight loss, because someone has not had enough food to eat or they had an infectious disease that suddenly limited their nutritional intake severely (World Health Organization, 2014a).

A child is officially wasted if his or her weight-for-height score is more than two standard deviations below the median for the reference of that age. Measuring the Middle Upper Arm circumference (MUAC) score is often used to diagnose wasting in LMICs, as it is a good predictor (World Health Organization, 2014a). Severe acute malnutrition (SAM) refers to severe wasting, which combines a very low MUAC score with oedema. Moderate acute malnutrition is defined as moderate wasting and a low MUAC score (World Health Organization, 2014b).

Stunting is defined as low height-for-age. It is the result of a chronic lack of nutritional intake, and is usually associated with poor caretaking practices early in life such as insufficient feeding, poor hygiene practices and frequent illness (Roser & Ritchie, 2019; World Health Organization, 2021a).

A child is stunted if his or her height falls two standard deviations below the median height-for-age of the reference standard for that age (World Health Organization, 2015).

Being micronutrient deficient means that there is a lack of vitamins and minerals. Iron, vitamin A and iodine are the most common micronutrient deficiencies, especially in pregnant women and young children in LMICs. Micronutrients are needed for basic bodily functions, and for growth and development (Micronutrients, n.d.).

4.2.2 Causes of undernutrition

Malnutrition is associated with reduced dietary intake, reduced absorption of macro– and/or micronutrients, or increased nutritional needs (Saunders & Smith, 2010).

Overall risk factors include socioeconomic status, poor hygiene practices, sources of drinking water etc (Fagbamigbe et al., 2020). Stunting is most prevalent in the poor parts of populations (Black et al., 2013).

Another important factor for undernutrition in the first stages of life is suboptimal breastfeeding. It is recommended that babies are exclusively breastfed in the first six months of life, with complementary feeding after. Estimates show however that only around half of infants are exclusively breastfed in the first two months in LMIC (Black et al., 2013).

Lastly, infectious diseases are an important cause factor for the various forms of undernutrition. Diseases such as diarrhoea lead to malabsorption of nutrients, so that even a child with sufficient feeding can suffer from undernourishment (Black et al., 2013)

4.2.3 Effects of undernutrition

The different forms of undernutrition have a negative effect on the whole body. It has a wide range of effects, from reducing cardiac muscle function, affecting the immune system and psychological effects to name a few (Saunders & Smith, 2010).

Wasting causes children to be too thin and have weak immune systems. In some cases, it also results in oedema, which is a swelling of the face or limbs. It makes them vulnerable to a wide range of diseases, and therefore comes with a critical risk of mortality (Nutrition and Care for Children with

Wasting | UNICEF, n.d.). In the long term, wasting can also have longer lasting development issues, with children potentially suffering from cognitive and health impairments (Karlsson et al., 2022).

Children that suffer from stunting do not grow tall enough for their age. It can have severe impacts on both the cognitive and physical development throughout their life (World Health Organization, 2014b).

Micronutrient deficiencies can have severe consequences. It can lead to a reduced resistance to infections, blindness, reduced growth, decreased school performance and even death (Stevens et al., 2022).

Generally, undernutrition is an important underlying risk factor for the diseases that cause the most child mortality globally (acute respiratory diseases, diarrhoea, neonatal sepsis and malaria), and it is estimated that 35% of child deaths can be attributed to undernutrition, directly and indirectly (Kolčić, 2012). The likelihood of dying from these diseases increases as the severity increases for stunting and wasting (Black et al., 2013).

4.2.4 Burden of undernutrition

The various forms of undernutrition are estimated to cause 45% of child deaths, resulting in 3.1 million deaths annually. In Africa, around 57% of children are estimated to be stunted and 4% are estimated to be severely wasted (Black et al., 2013). One third of the world's population is affected by micronutrient deficiencies, the majority living in developing countries. The four most common forms of micronutrient deficiencies (vitamin A, zinc, iron and iodine) account for 11% of child deaths (Ahmed et al., 2012)

	Children <5 years in millions[2] [7]	Percentage stunted (95% CI)	Number stunted in millions (95% CI)	Percentage severely wasted (95% CI)	Number severely wasted in millions (95% CI)	Percentage underweight (95% CI)	Numbe underv in milli (95% C
Africa	141·914	40·1 (36·8–43·4)	56·9 (52·2–61·6)	3·9 (2·2–5·7)	5·6 (3·0–8·0)	21·9 (19·8–24·0)	31·1 (28·34·0)
Eastern	48·807	50·0 (42·3–57·9)	24·4 (20·7–28·3)	3·6 (1·5–8·4)	1·8 (0·7–4·1)	28·0 (23·6–32·9)	13·7 (11·16·1)

Figure 4.1 Burden of childhood undernutrition in (Eastern) Africa (Black et al., 2013)

In Lamu, undernutrition is the most important driving risk factor for deaths and disabilities. It does not list the top causes of deaths directly. The latest nutritional survey showed that 29 percent of children in Lamu are stunted while 4.2 percent were wasted. There were no records for micronutrient deficiencies. (Healthdata, 2020)

4.2.5 Patient journeys for accessing healthcare

When it comes to seeking help from healthcare, people typically go through several stages as they seek help in healthcare systems. These stages can broadly be defined as prevention, diagnosis, treatment and finally, recovery, see figure 4.2.

In the prevention stage health risks and awareness play key roles. Health risks include lifestyle factors such as eating habits and being physically active, as well as not smoking and not using other substances are essential to reduce the risk of all kinds of disease. Furthermore, health risks that can contribute to an increased risk of disease are related to the environment that people live in such as living in cities with air pollution or being in locations with an unsafe water supply. Besides health risks, awareness is another major factor here. When people have an awareness of relevant diseases and what causes them, they are inclined to adjust their day-to-day practices to reduce the risk of those diseases. An example of this is that people who are aware of the causes of chronic diarrhoea will be more inclined to make sure they have hygienic washing habits.

Once a disease has not been prevented there are several typical steps in the broad stage of diagnosis. First, the symptoms of a disease develop, after which the symptoms have to be noticed and be severe enough that people decide to seek help. After travelling to a health facility, they are diagnosed by a health worker. If a disease is diagnosed, they then get the result.

Following diagnosis comes the treatment stage. The type of treatment needed and for how long depends entirely on the disease. An important aspect of treatment includes adherence to the treatment. This can be difficult, as people often stop treatment prematurely when the symptoms have subsided but the disease has not been cured completely.

The final stage of the health seeking pathway is the recovery stage. During this stage, if the treatment is successful and has been adhered to, rehabilitation takes place.

4.2.6 Prevention and diagnosis of undernutrition

Growth monitoring is a key component of community-based health programs and of UNICEF's strategy to improve overall nutrition and prevent development of undernutrition in the first stages of life (Liu et al., 2017). Its purpose is to measure and track physical development in the first years of life. It is done through taking weight and height measurements and plotting them along the age once every month. Its effect is thought to be double. On the one hand, growth monitoring can detect any problems in an early stage and therefore promote timely measures to be taken such as counselling or referral. On the other hand, an effect of growth monitoring is seen as an effective measure to increase awareness of the importance of nutrition to mothers and facilitate the exchange of knowledge between mothers and health care workers (Liu et al., 2017).

The overall effectiveness of community-based growth monitoring has been up for discussion. Its impact is not significant as a stand-alone intervention (Bukari et al., 2020). It therefore needs to be part of a comprehensive program and can serve as a platform of delivery for further interventions (Mangasaryan et al., 2011).
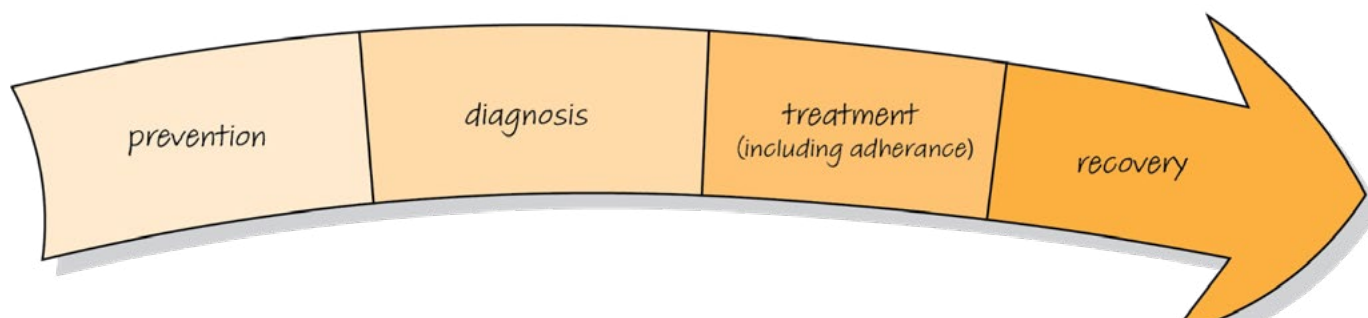

Figure 4.2 the typical stages of a healthcare journey

Figure 4.3 different types of anthropometric measurements are used for determining undernutrition (UNICEF, n.d.)

The different forms of undernutrition are mostly diagnosed through anthropometric measurements. Checking for clinical signs such as lethargy, or oedema can further help in determining the severity of undernourishment (Black et al., 2013). Growth monitoring is done by measuring weight and length/height on a monthly basis. The anthropometric measurements that are needed to diagnose undernutrition are weight, length/height and MUAC, see figure 4.3.

Weight is measured through a weighing scale. The type of weighing scale used is dependent on the context of measurement and the age of the child. Infants that cannot yet stand can be weighed in three ways:

- On an infant weighing scale while lying down

- On a regular weighing scale by first measuring an adult, zeroing the scale and then holding the infant

- Using a hanging weighing scale, by placing the infant in a piece of cloth..

Middle Upper Arm Circumference (MUAC)-tape is used to measure the arm circumference. There are different MUAC-tapes for different age groups. The colours on the tape indicate the severity of malnutrition and makes it easy to see what steps need to be taken. If the score is red, referral to a facility is urgently needed. For yellow, consultation with a CHV might be enough. Green indicates a healthy child.

There is a difference between *length and height* when it comes to measurements. Recumbent length is taken with the infant lying down, and measures from the top of the head to the soles of the feet. Height is taken standing up and measured from the top of the head to the plane that is stood upon. (Gripp et al., 2013)

Length is measured lying down using a wooden board, rollable height mats, using measuring tape or a stadiometer. *Height* is measured using wooden boards, measuring tape, stadiometer etc.

Accuracy needed for anthropometric measurements

According to the World Health Organization and UNICEF, to ensure that anthropometric measurements are reliable, the required accuracy and precision for weight measurement is better than ± 0.15% or ± 100g. For length or height measurement, the accuracy and precision required is 2mm, with demarcations at every 1 and 5 mm and numbers at every 1 cm (World Health Organization UNICEF, 2019).

4.2.7 Treatment and recovery of undernutrition

Wasting can be treated through increased nutritional intake and treatment of infections (Roser & Ritchie, 2019). In LMICs, the nutritional intake is usually improved through ready-to-use therapeutic food (RUTF). The daily dose of RUTF that is needed for the child needs to be adjusted to fit the child and the stage of wasting (International Rescue Commity, 2018).

Stunting is difficult to treat, as once a child is stunted the effects are hard to reverse. Single interventions that might help include providing supplements and/or improving caretaking practices. Emphasis should therefore be on early recognition of warning signs and preventative measures (World Health Organization, 2015).

Micronutrient deficiencies can be treated through supplements and improved feeding habits.

4.4 Chapter conclusions

Unhealthy nutrition is present in both under and overnutrition, with undernutrition a more significant burden in sub-Saharan African countries like Kenya. Undernutrition has three broad forms, wasting, stunting and micronutrient deficiencies. Each form of undernutrition is diagnosed by doing a different set of anthropometric measurements, using relatively simple tools. Weight, recumbent length or height and upper arm circumference are the main anthropometric measurements needed. The products to do this are weighing scales, rollable or standing height metres and MUAC-tape. Growth monitoring is outlined as an effective preventative strategy for undernutrition in young children where physical development is measured and plotted on a monthly basis. Wasting is the most visible form of undernutrition and is regularly treated. Stunting is hard to treat and so emphasis should be on prevention and recognizing early warning signs. Micronutrient deficiencies are less visible but can be treated through supplements.

4.4.1 Key takeaways for interventions

Requirements:

Interventions should focus on prevention or early recognition of the various forms of undernutrition to be most effective

Desirability

Interventions could make use of anthropometric measurements for diagnosis and prevention of undernutrition, as they are available, affordable and not overly complex

Feasibility

Opportunities:

Anthropometric measurement tools must have an accuracy as outlined by the WHO standards

Feasibility

A stall on a street in Lamu selling fruit juice and some snacks

SECTION 3

// Understanding Lamu //

Chapter 5: Understanding Lamu culture
Chapter 6: Understanding Lamu nutrition and healthcare
Chapter 7: Understanding Lamu technology

After establishing a health challenge focus and diving deep into the medical perspective in the previous chapter, this section focuses on understanding the context of the project, Lamu, when it comes to (un)healthy nutrition. By understanding (un)healthy nutrition in Lamu from a cultural, healthcare and technological perspective a systemic understanding of the context is gained, which will serve as the basis for the designing of interventions in the next section.

Chapter 5: Understanding Lamu culture

This chapter describes what stands out about the local culture from a societal, community and family perspective. By understanding the local culture on these levels, the relevant cultural opportunities and possible constraints are uncovered.

5.1 Approach

To gain a brief understanding of Lamu culture, we first describe the culture on a zoomed out and broad scale in the general cultural identity of the county. Next, we zoom in and focus on the communities. Finally, we explore the daily lives of caregivers in Lamu. To form the insights, literature research, fieldwork interviews and observations are combined.

Chapter research questions:

The research question that this chapter aims to answer are:

- What cultural factors are important to take into account to improve nutritional outcomes in Lamu?

  - What cultural factors typify the local society at large?

  - What cultural factors typify the local communities?

  - What cultural factors typify the lives of local caregivers?

5.2 Lamu society

Lamu is inhabited by diverse social groups, members of different tribes can be seen walking around in the streets. Most of the population is Muslim, and there are strong aspects of Swahili culture. The traditional values are valued, and they are proudly celebrated during the yearly cultural festival.

Lamu is generally considered to be quite conservative, which is seen in the social norms and behaviours. There is a strong emphasis on modesty, respect for authority, and adherence to religious and cultural practices. This conservatism can be seen walking on the streets in Lamu and observing the various aspects of daily life, including dress codes, gender roles, and social interactions. For example, women typically dress modestly and cover their heads and bodies.

Structures are often informal in Lamu, such as when it comes to employment or how communities are made up. Hierarchy also plays a big role. This was exemplified during the starting up of the fieldwork, when we were discussing who could be interviewed. To talk to a specific group of stakeholders you often first had to get permission from layers above in the hierarchy. So when wanting to talk to caregivers, it was crucial to first discuss with the community leader, and in order to talk to the community leaders it was important that we first discussed with the public health officers.

Walking on the streets in Lamu you see the diversity in clothing and the muslim influence

A square in Lamu old town facilitates the social cohesion that exists

5.3 Communities

There is a strong sense of community throughout the area, and communities make up the fundamental building blocks that make up the social fabric of the area.

Social cohesion of communities

There is a strong social cohesion within the communities. Communities in Lamu tend to have close relationships with one another, and social interactions play a crucial role in their daily lives. The locals work together to support each other and people know each other by name.

Informal networks

Within communities there are strong informal networks. The extended family is an essential part of these informal structures in Lamu. The extended family provides support to each other in times of need, and they share resources and knowledge. Family and extended family networks also play a vital role in childcare, with grandparents, aunts, and cousins often sharing the responsibility of raising children. Community leaders are also important in the informal networks in communities. They are trusted and have a role of authority, and play a crucial role in communities, in setting up new interventions and in dissemination of information.

5.4 Lives of caregivers

Traditional gender roles

In interviews with caregivers it also became obvious that gender roles are quite traditional, with men typically seen as breadwinners and women as caregivers. Men are frequently not very involved in the raising of the children, and women are often reliant on their husbands to provide income and food.

"Many times the men are not taking care because the whole day they are outside they are looking for the bread, so she has to take care of the children" - Caregiver

Lack of stable jobs

Due to a lack of economic opportunities in the area, many men have to rely on taking up multiple jobs to make ends meet. Often, these jobs are informal and lacking in stability, meaning that there's no guarantee of regular income or job security. This can create a lot of financial stress and uncertainty for families, as well as making it difficult to plan for the future.

Busy lives

Life for families in Lamu is characterised by a busy routine. For the men, due to the lack of stable jobs, they are often out for the whole day gaining income. For children, their days are filled with long hours of school, and on their days off, they attend "madrasa." And for the women, they are occupied with the traditional housework and raising of children.

Social problems

Social problems are prevalent among families in Lamu due to the difficult circumstances they face. Interviews revealed that single motherhood and substance abuse are unfortunately not uncommon issues affecting families in the area.

"I wish you could see the kids, they are innocent to the troubles of the parents, the parents are having a hard time. There are a lot of single parents that are having a lot of stress problems" - ECD coordinator

Most men work a variety of informal jobs to provide income for their families

5.5 Conclusions

In conclusion, Lamu is a diverse region with a strong sense of community and social cohesion. Traditional values and conservative social norms are prevalent in the region, which can be seen in dress codes, gender roles, and social interactions. There have been concerns around security in the area which limits the amount of outside help the region gets. Communities are the building blocks of the social fabric, with strong informal networks of extended families and community leaders playing important roles. Lives of people in the region are characterised as busy. There is a lack of stable economic opportunities, and social problems can be a prevalent issue affecting families in the area.

5.5.1 Key takeaways for interventions

Requirements:

- Interventions should accommodate caregivers, as they have busy and challenging lives

Desirability

- Interventions should not go against the strong local cultural, social and religious identity to increase acceptance

Desirability

- Interventions should build on the strong social cohesion and informal structures that exist

Desirability

- Interventions should be designed and implemented together with relevant stakeholders, such as community leaders, to increase the chance of acceptability

Viability

Opportunities:

- Interventions could provide economic opportunities to locals, as they are sought after in the region

Desirability

Coral bricks are often used as construction material for the houses in Lamu towns

Chapter 6: Understanding Lamu nutrition and healthcare

In this chapter, the nutritional practices and nutritional healthcare in the first 1000 days in Lamu is understood. The insights are formed mainly by the interviews during the fieldwork, and aim to understand the local problems, needs and opportunities when it comes to improving on nutritional health for young children in the region.

6.1 Approach

This chapter aims to understand the makeup of the local society, local context of nutrition and local healthcare. These insights are mostly based on the fieldwork. The literature research from the previous chapter was used to prepare the fieldwork. The fieldwork, which consists of a combination of interviews and observations, gives qualitative insights to get a good understanding of the local context.

6.1.1 Chapter research questions

The main research question that this chapter aims to answer is as follows:

- What are the local needs for improved healthy nutrition in the first 1000 days?

    - What are the challenges around nutrition practices in the first 1000 days in communities in Lamu?

    - How is the healthcare system structured?

    - What are the contact points with healthcare in the first 1000 days in Lamu?

    - What are the relevant stakeholders for communities when it comes to nutritional healthcare in the first 1000 days?

    - What is the patient journey for caregivers when they seek help for their infant in case of undernutrition?

- What are the barriers to accessing healthcare for nutrition?

- What are the resulting problems regarding suboptimal nutritional health outcomes and related inequalities in the first 1000 days in Lamu?

6.2 Nutrition practices in Lamu in the first 1000 days

6.2.1 Typical diet

An example of a typical day in food is presented in figure 6.5.

"Breakfast many times I just buy some bread. If I can describe a bread here the family bread, two breads cost me 140 plus sugar and tea 200. If I want to cook food it will be more expensive. For lunch in Lamu you take rice, I can take ugali but mostly rice. Next to the rice we have fish or some meats and soups, we buy the bones of the cows or goats we boil and make soup. Dinner we eat the rice that is left, if it is little we add some bread." - Caregiver

Chapati with beans is a staple of many Lamunians' diet

an example of an....
IDEAL LAMU DAY FOOD MENU

Breakfast:

a variety of fried goods such as vibibibi (rice and coconut pancakes), samosa's (fried pastries with a filling inside) or mandazi (a deep fried pastry). Tea.

Lunch:

A combination of rice or ugali (maize flower meal) with fish or meat. Examples are pilau or biryani. Some vegetables such as mchicha (a type of spinach) might be eaten as well.

Dinner:

Chapati (fried flatbread) with beans.

Infant's menu:

Exclusive breastfeeding (up until six months) and suited complementary feeding

an example of a....
REALISTIC DAY FOOD MENU

Breakfast:

White bread with tea.

Lunch:

Rice with soup (made from bones of goat)

Dinner:

Leftovers from lunch with some extra bread

Infant's menu:

Breastfeeding and the same as what the parents eat

Figure 6.1: An example of a typical ideal and realistic day in food in Lamu

6.2.2 Problems around nutrition in the first 1000 days

For many, it is a daily struggle to put food on the table. People are therefore forced to eat what they can afford, rather than what would be a sufficient and balanced diet.

People often eat just once a day, or rely solely on chapati and beans for every meal. There is an over-consumption of certain cheap but nutritionally poor foods such as fried potatoes, rice and fried doughs. Vegetables are often missing in diets, as people cannot afford them or they are not available due to seasonal availability issues.

"For me, it [undernutrition] is a problem, sometimes you don't get a proper diet, where you just have bread the whole day, or potatoes all day. There are some families who only eat chapati and beans every day." - Caregiver

There is a lack of awareness on the importance of a varied and sufficient diet, especially in the remote regions.

"Especially in areas where literacy levels low they are not aware. In areas where the literacy levels are to the standard at least they are aware." - NGO

Cultural superstitions about feeding habits during pregnancy can negatively affect dietary intake. Pregnant women can for example avoid eggs throughout pregnancy as they are believed to cause infections in the foetus.

"Superstitions about feeding habits during pregnancy can negatively affect dietary intake" - Hospital nutritionist

Caregivers expressed that doing exclusive breast-feeding can be challenging. It is an extra burden on the day-to-day, and with many people having stressful lives due to social and economical concerns they do not exclusive breastfeeding as another burden to stress about. Furthermore, children are often raised by the extended family as well. Exclusive breastfeeding is difficult to achieve if for example the "nani" feeds the baby something else.

"Breastfeeding is a problem with our kids, because of the condition and community. Maybe I am doing exclusive breastfeeding and I leave them with a nani and she feeds the baby something else, so it's difficult to do exclusive breastfeeding." - Caregiver

Food security has recently become an increasing problem as the seasonal rains have become unpredictable and global events such as Covid-19 and the war in Ukraine have raised prices of resources, among which the price of grain and fuel. Lastly, many communities in Lamu do not have easy access to a clean water source. Many people rely on buying bottled water.

"People cannot afford to buy vegetables. There are also not enough vegetables available during the dry season" - MCH doctor

A typical breakfast served at a gathering with officials, including many fried doughs and fruit salads

4.3 Healthcare in Kenya

Healthcare in Kenya comprises different systems and has several settings for healthcare services. There is a main distinction between the public and private systems, which typically deliver services in their facilities. Another strategy, as recommended by the WHO, is to provide basic health services on the community level through a system of community health volunteers (CHVs). An overview is presented in figure 6.2.

4.3.1 The public and private health care system in Kenya

As in most countries, healthcare in Kenya can be split up into public and private healthcare. The public sector in Kenya is responsible for providing healthcare services to the majority of the population. This sector includes national referral hospitals, which are the largest and most advanced hospitals in the country and provide specialised care to patients. The public sector also includes regional hospitals, district hospitals, and health centres, which provide more general medical services to local communities. In addition, there are many local dispensaries and clinics, which offer basic healthcare services such as vaccinations and treatment for minor illnesses. The private sector in Kenya, on the other hand, includes for-profit hospitals and clinics, as well as non-governmental organisations (NGOs) and faith-based organisations (FBOs) that provide healthcare services. These facilities may offer more specialised or advanced medical services or reach out to communities that are underserved by the public health system, as well as alternative forms of healthcare such as traditional medicine (Muga, R. et al., 2005).

Healthcare financing in Kenya comes from three sources: Out Of Pocket payments (OOP), government expenditure, and donors such as NGOs. OOP payments are funds that households use to pay for healthcare and accounted for nearly 25% of total health spending in 2010. For a significant portion of the population, OOP payments pose a barrier to accessing healthcare because they lack the necessary funds (Munge & Briggs, 2014).

There are efforts to establish a Universal Health Care system, but up until now only 20% of the population is insured by any coverage. The largest public health insurance provider, the National Hospital Insurance Fund (NHIF), only covers about 15% of the population. A major contributing factor to this low coverage rate is that many Kenyans work in the informal employment sector, where insurance is voluntary. Even among those who have health insurance coverage, significant inequalities exist. This is not surprising for the private health sector, where the ability to pay determines one's contributions. However, it is notable that forms of health insurance that are intended to serve the poor, such as public health insurance, also exhibit significant inequalities (Kazungu & Barasa, 2017).
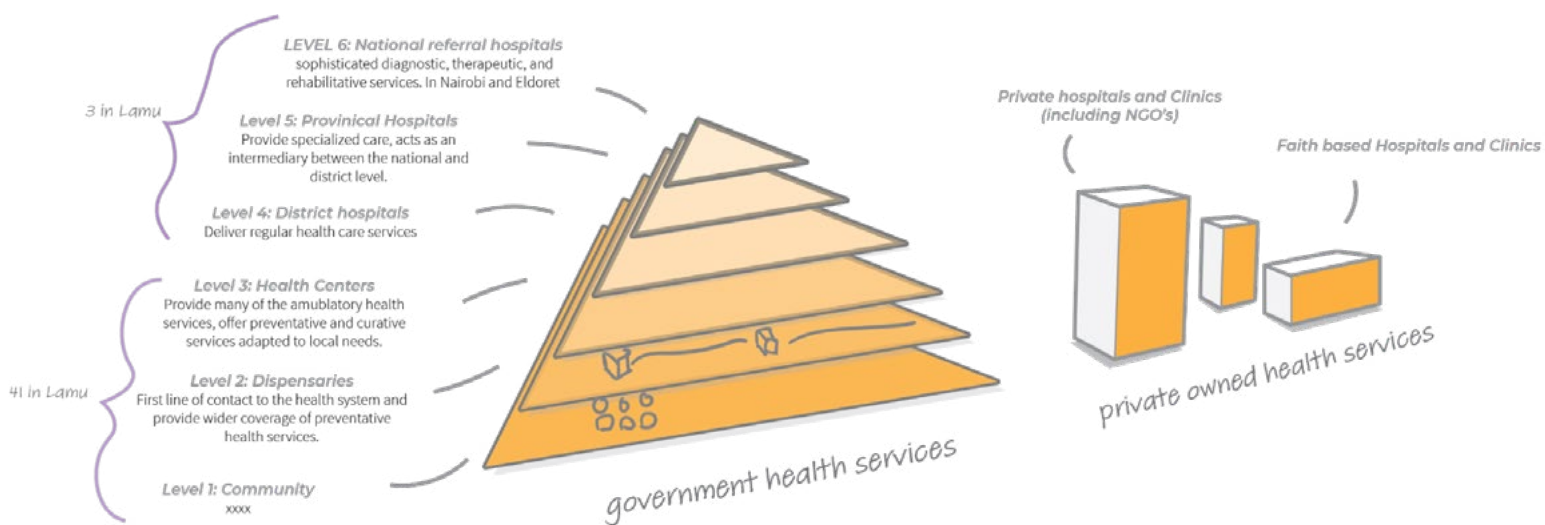

Figure 6.2: An overview of the healthcare system in Kenya including the different levels of facilities in the public sector as well as the private sector

Community Health Volunteers (CHVs) are central in the integrated community case management approach (Amref Health Africa, n.d.)

4.3.2 Community-based healthcare

To promote health of children in communities in LMICs, the WHO has recommended the adoption of integrated community case management (iCCM). iCCM is an approach that focuses on providing healthcare services for common diseases at community level, outside of healthcare facilities. It focuses on equipping training and supervising community health volunteers (CHVs) to provide these services. As the approach focuses on communities rather than facilities, it can improve the health in remote areas and vulnerable populations. It is therefore especially useful for communities that live far away from facilities and that are served by resource-constrained healthcare (Young et al., 2012). Kenya has started to adopt iCCM as a structural part of its healthcare delivery structure, though structural investments, as well as investments in a well functioning primary health care system are needed (Child Health Task Force & USAID, 2021).

Driving forces for iCCM include strong community commitment, commitment from governance through appropriate policies and the potential for using private sector initiatives for implementation (Awor, 2021).

Some of the challenges for iCCM include weak supply chain systems (with limited tools and treatment available), weak supervision of CHVs, lack of financial support for CHVs and a reliance on external funding (Chilundo et al., 2015).

iCCM has, despite these challenges, proven to be effective in managing some diseases on a community level. Examples of this include in managing simple cases of pneumonia, where CHVs diagnose based on clinical symptoms and treat non-severe cases with antibiotics and refer to facilities if necessary. Also, iCCM is increasing access to necessary interventions for children with malaria, diarrhoea and promoting healthy nutrition, improved care seeking and adequate referral to facilities where necessary (World Health Organization & UNICEF, 2004). Furthermore, the CHV system allows for communities to receive communication and information about good practices for health and nutrition (Oliphant et al., 2021).

6.3 Healthcare services in Lamu in the first 1000 days

6.3.1 Healthcare contact points in the first 1000 days

Looking at the amount of times (soon-to-be) parents and infants are seen within health facilities in the first 1000 days there is a difference between the "ideal" or prescribed scenario and what regularly happens in reality, see figure 6.3.

Ideal scenario

Throughout the pregnancy in Lamu, people are supposed to come into a health facility four times at minimum, which is in line with recommendations of the WHO. These antenatal care (ANC) visits are used for maternal and foetal assessments and preventative health interventions to promote a healthy pregnancy. Giving birth is supposed to be done in a facility under guidance of a skilled birth attendant. After giving birth, parents are supposed to come in with their infant for vaccinations, supplements and growth monitoring. In principle, growth monitoring is done at the same time as vaccinations. People are supposed to come in six times in the first year of life. During these visits, vaccinations for various diseases such as polio, DTP, tuberculosis etc. as well as vitamin A supplements are administered. Also, growth monitoring is supposed to be done during these visits.

Realistic scenario

In the realistic scenario, people are seen less in facilities in the first 1000 days. Only about half of the people come into facilities for ANC visits. This is probably caused by accessibility concerns and the lack of recognition of the importance of ANC visits.

"People are supposed to come in for four visits during pregnancy, but a lot of people don't come. Attendance rates for the fourth ANC visit is around 57%" - Nutritionist

Giving birth is sometimes done at home by a traditional birth attendant rather than in a facility by a skilled birth attendant. This comes with extra risks, as in case of complications the traditional birth attendants are underskilled and/or underequipped.

"Skilled delivery is recommended, but sometimes Traditional Birth Attendants skip that advice to make some extra money and deliver the baby" - MCH doctor

People are known to not come in for every vaccination. This can be due to people forgetting their visit, not being able to come to the facility due to accessibility concerns or smaller causes such as illness. Most of these concerns are especially present in the most remote communities, for whom getting to facilities is the most challenging and who are often the least aware of the importance of regular visits.

"If I'm ill I'm not going to the facility for the vaccination or something." - Caregiver
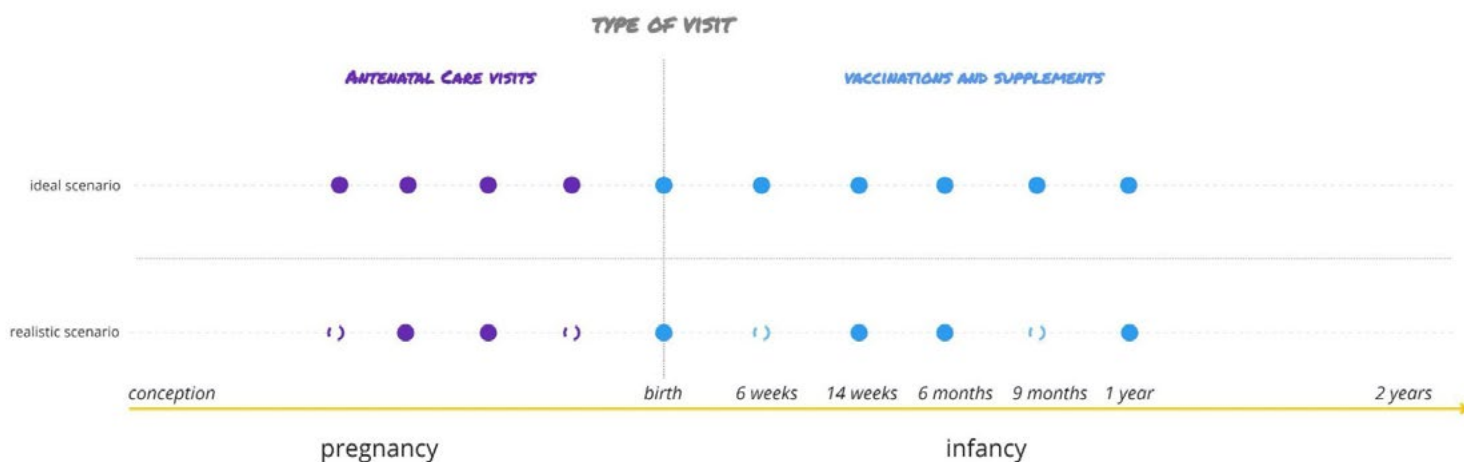

Figure 6.3: Contact points for caregivers with facilities in the first 1000 days

"Communities that are more remote and hard to reach might not make the effort for the visits" - Nutritionist

Unlike vaccinations, growth monitoring is not recognized as a big enough reason for people to make the effort to visit a facility.

"The perception is that growth monitoring is not a big thing compared to vaccinations" - Hospital nutritionist
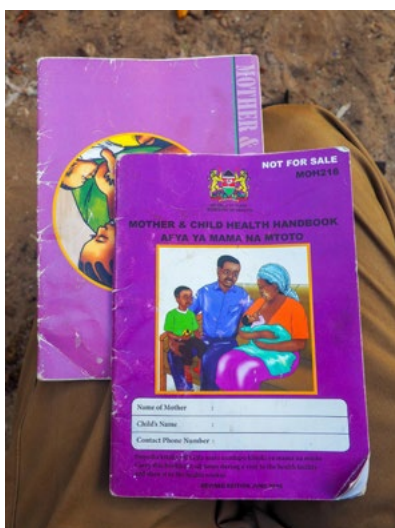
6.3.2 The mother & child health handbook

The mother and child health (MCH**) handbook, is distributed by the Ministry of Health to everyone that has a child in Kenya. It is distributed via the public health system. It serves two functions. The first is to provide parents with information on good health practices during pregnancy and in the first years of life, including advice on things such as breastfeeding,and dental health of the newborn . The second is to track the health of a child in the first 5 years of life by noting down vaccinations received, growth development etc.

The MCH handbook is kept by the caregivers, who are to take it with them anytime they visit a health facility for an ANC visit, postnatal visits and vaccination and growth monitoring appointments. During the appointments, the health worker is supposed to fill in the booklet.

During interviews, caregivers expressed that they value the handbook. They enjoy having a document that they can look back on that follows the development of their child. There are however several issues with the booklet. One issue is that caregivers can easily misplace the handbook, leading to a lack of access to important information. Another problem with the handbook is that it contains a vast amount of information, tables, and charts, which can make it difficult for caregivers and health workers to have a good overview and quickly find the information they need or what still needs to be filled in. This leads to the third issue with the handbook. During fieldwork, it was observed that often only the vaccination section of the handbook was properly filled in. The growth monitoring section for example of the handbook was not mapped out in the books that were seen during interviews. The health workers in facilities are often short on time and often just give the vaccinations when people come in and skip the growth monitoring, which is seemingly not helped by the structure and format of the handbook. Another reason that was expressed in interviews why the growth monitoring was often not done is that it is not recognized by communities as important.

"They don't see growth monitoring as important, so when you consider that they have to leave their household work, have to pay for travel, they are taking care of other children and needing to be washing clothes, this is the same person that also needs to take the child to be diagnosed." - Public Health Officer

The mother and child health handbook as seen during the fieldwork
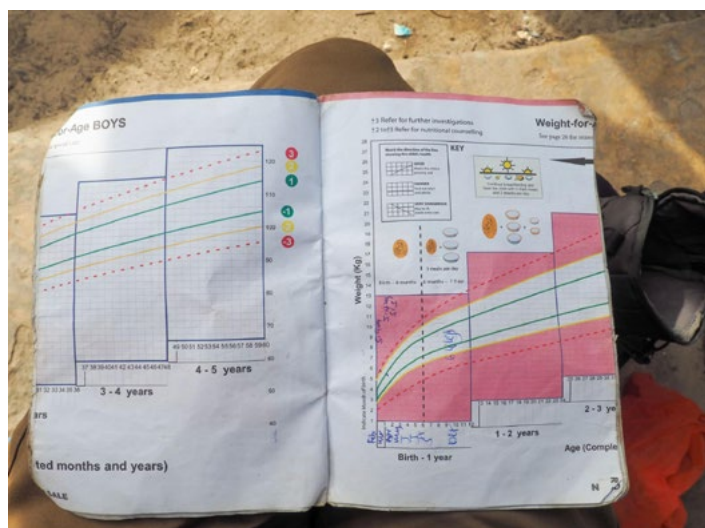
The growth monitoring section of the handbook was at best partly filled in in the ones that were seen during the interviews

6.4 Stakeholders for healthy nutrition in the first 1000 days in Lamu

In order to understand who caregivers come into contact with when it comes to nutritional health-care in the first 1000 days a stakeholder map and their interactions is visualised, see figure 6.4. The main groups of stakeholders are visualised as floating islands. Within each group, the relevant stakeholders are visualised as characters and/or structures. The purple lines illustrate the interaction between the stakeholders, which are described below.

Communities form the centre of the stakeholder map, as this is what the caregivers are part of and thus contain the people that they interact with on a regular basis. Caregivers are helped out by their extended family, which include relatives or neighbours, and they might discuss with them when they are experiencing problems. Caregivers might also consult their community leader, who is usually the spiritual or religious leader of the community. Caregivers can be assessed and referred for basic health issues and are educated on health matters by their CHV. Whenever caregivers are referred by their CHV or they seek medical help by themselves, they will go to their nearest health facility. In most cases, this is a lower level dispensary, where basic procedures can be carried out. If they need more help however, they have to go and seek help at a higher level public facility or private facility.

"The CHV's are crucial in the work, it's easier to work with them. They know the community, as they are the people they call to refer to them." - NGO director

Health facilities are divided into public and private facilities. For the public facilities, there is usually a facility close to the communities, which is often a
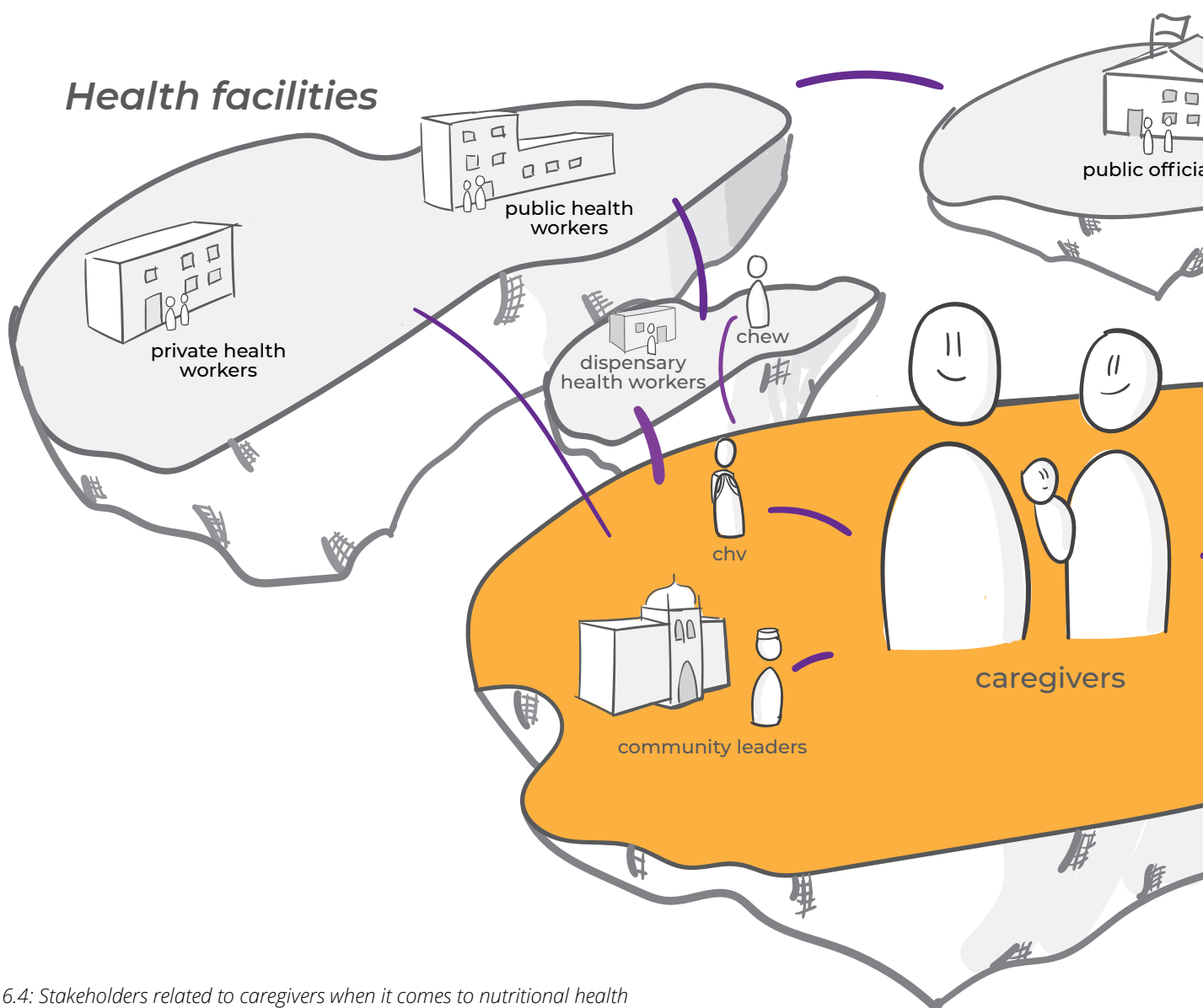

Figure 6.4: Stakeholders related to caregivers when it comes to nutritional health

lower level facility such as a dispensary where basic procedures can be carried out. A larger referral facility is often further away from the communities. The dispensaries report back to the referral hospital. For the private health system, which includes for-profit clinics but also organisations such as faith-based clinics. Caregivers often prefer to go to private facilities if they can afford it, as the quality of care and availability of resources can be higher in those facilities. The CHEW (**) monitors the CHV's and therefore plays a coordinating role. There can be a lack of trust among community members of public health facilities. For example, they might have had experiences where there was no medicine available at the facility.

"If you have no alternative I go [to the public facilities], but if I got some money there is a private clin-

ic, you pay a lot of money but there is good medication." - Caregiver

"We give back the report we talk to the CHEW, we have a report about the community, how often we see the chew depends, if there is something we don't understand the chew can come" - CHV

NGO's are initiating various projects to improve community health as well as doing outreaches. During outreaches, a team of NGO health workers goes out to communities to provide basic health services.

"We do medical outreaches. When we do outreachers, we have CHV with us that we train on health issues that affect the communities. We encourage them to come in and teach on various topics." - NGO health worker

Government is the final important group of stakeholders. Closest to the communities is public health, from which the public health officials are responsible for carrying out community health programs, supplying and training the CHV's and improving the system. The work they carry out is in accordance with the policy as set out by the county government and in turn by the national government.

"We run programs of interaction with community that are around engagement. We interact with schools etc. We do some capacity building but in most cases this goes to community leaders as they help to disseminate the informa-

Government

NGOs

NGO workers

extended family

Communities

tion down to the family level" - Health promotion officer

6.4.1 The role of the CHV

Throughout the interviews, almost everyone agrees that the CHV's could play a bigger role when it comes to health services in the region. The system of CHV's has been put in place in accordance with national policy, as recommended by the WHO. Currently, CHVs, tasked with disseminating information within communities and doing basic referrals. Many, including the CHV's that were talked to, expressed ambition to play a bigger role in linking the communities with facilities.

Financial compensation for CHV's

When discussing a bigger role of the CHV, it was mentioned in almost every interview that they should receive financial compensation for their task. At the moment, everything they do is on a volunteer basis. For most, the motivation to become a CHV is to be able to take care of the community, get education through training and/or see it as a stepping stone to a next job. Without financial compensation however, it is

"The CHV's could play a bigger role [than they currently do], but only with the right motivation. If they lack the motivation, through the stipends, we have to pull and push them. There are plans from the governments but at the moment they are not there sustainably, they are not paid in Lamu county. Sometimes they can be motivated through training or allowances. They have their own social lives and things to take care of. When you tell them to come to training and they have to travel from far away and have to pay for the transport themselves it is not fair."
- Dispensary health worker

A caregiver and her child who was interviewed and who used to be CHV for her community, sitting in front of her home

hard to rely on CHV's to form an integral part of the health service delivery system.

6.5 Barriers to accessing healthcare for undernutrition

6.5.1 Barriers for caregivers seeking help for various forms of undernutrition

Now that we know when people are supposed to come in regularly, we will look into what happens when people are confronted with the three types of undernutrition. What is it like to access healthcare on an individual level?

In order to understand the barriers that exist in Lamu to accessing healthcare, we asked caregivers, health workers and other relevant stakeholders about those barriers. The insights from those interviews are presented below in the form of patient stories, see figure 6.5.

Choosing this personal perspective both demonstrates the barriers on a personal level as well as allows us to sympathise with the challenges that people face when accessing healthcare. These are described in the form of patient stories; these are fictitious narratives that illustrate what it is like throughout the health seeking pathway for wasting, stunting and micronutrient deficiencies.

The stories are divided into seven phases; getting undernutrition, developing symptoms, seeking help, getting diagnosed, getting treatment, going back, and recovering. from developing symptoms to recovering.

There are three different settings throughout the stories; parts of it are at home in the community, others are while travelling, and the third setting is while in a health facility.

In some stories, the line moves back and forth through the various stages, this indicates that some steps are repeated throughout the story, such as when having to come back to a facility multiple times or progressively developing symptoms without seeking help.

Figure x: visual representation of fictitious patient stories for caregivers who seek help for various forms of undernutrition in Lamu

Wasting (1) "Fatma":

1. 4 months after giving birth to her second child, Fatma's husband leaves and doesn't come back.
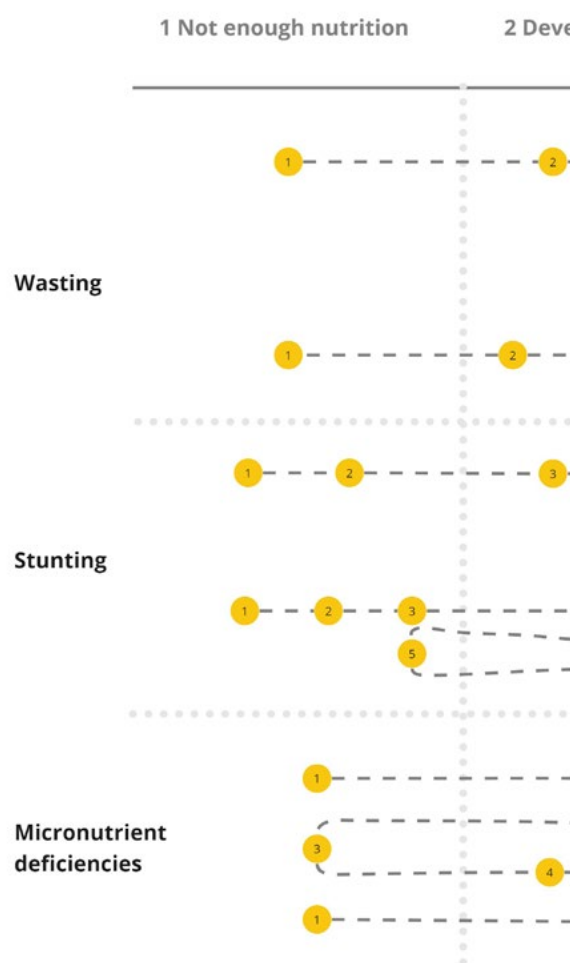
This puts an enormous strain on her, as she now has to provide income and food for her young daughter as well. She tries to get by, but she is unable to buy enough food. In turn, she is unable to give sufficient breastfeeding.

2. At first, the effects seem minimal, but slowly her daughter starts to lose weight, and her arms and legs start to become thinner. Fatma is preoccupied with the daily stress of family life, and tries to ignore the first signs.

3. After the signs start to worsen over the next weeks, extended family and people in the community start to notice and talk about it to Fatma.

4. She asks the CHV that lives close to her for help, who warns Fatma that her child is wasting and that she should go to the nearby hospital.

6. Fatma is fortunate to live close to the hospital. She leaves her other child with a family mem-

ber and carries her young daughter on her back wrapped in a cloth for the 15 minutes walk to the hospital

7. After waiting in line in front of the hospital for some time, Fatma is seen by the hospital nutritionist who measures the weight, height and upper arm circumference of her child. Her upper arm is too thin, and moderate wasting is diagnosed

8. Fatma gets ready-to-use therapeutic food (RUTF) from the hospital, and is instructed on how much she needs to feed her child each day and is instructed to return in a week to see if her child has progressed.

9. After having finished at the hospital, she walks back home.

10. At home, Fatma has to resist the urge to use the RUTF to feed her other child as well, but she manages to stick to the treatment. Slowly, her child

seems to recover.

11. She returns to the hospital for the follow-up a week later

12. The progress is confirmed by the nutritionist at the hospital and the dosage of RUTF is adjusted.

13. Fatma walks back home again

14. After another week, her child has recovered well.

Stunting 2 "Mariam":

1. Throughout Mariam her pregnancy, poor hygiene practices and unsafe water cause regular diarrhoea and reduces her hunger.

2. The CHV in her community goes to check up on her, and talks about the issues with Mariam and her husband. He tells them about the potential

Phases of undernutritioning in the first 1000 days of life

Figure 6.5: Fictitious patient stories for caregivers seeking help from healthcare facilities for infants suffering from various forms of undernutrition

consequences and advises them on what they can do to improve the pregnancy.

3. She talks about the visit to her husband. The daily stress of life, getting income and dealing with 4. the pregnancy makes it difficult to make meaningful changes however.

5. The child is born at a facility, which is not too far from their home. It is born prematurely and underweight. The nutritionist in the facility advices her on what to do next.

6. Poor sanitation and not enough nutrition remains there after the child is born.

7. Two months after birth, she and her husband start to worry. Their baby does not seem to be growing enough.

8. Because they need to go for vaccinations and they want to get help, Mariam takes a day to walk to the nearby facility.

9. The local facility checks up on the child when it comes in for the vaccinations. The height and weight of the baby is taken, and stunting is diagnosed.

10. The nutritionist tells her that the effects of stunting are hard to reverse, but again advices her on the importance of good hygiene and nutrition practices.

11. Mariam returns home, but is unable to make any significant changes to her feeding and hygiene habits.

Micronutrient deficiencies 1 "Abud"

1. Living far away in a community in the Boni forest, Abud and his wife live on a diet of what is locally available, which consists mainly of ugali, potatoes and rice. Sometimes, they can afford to have some meat or fish, but not often.

2. In the pregnancy, his wife is constantly fatigued. The baby is born and everything seems fine.

3. The baby gets fed the same as his parents, alongside breastfeeding.

4. The poor variety in the diet leads to the mother and the child both being constantly fatigued and weak.

5. To combat the symptoms, Abud tries some traditional medicine that the community leader recom-

mends when he asks him for advice. He tries this for a couple of weeks, but it does not help.

6. Abud now has to consider whether he seeks help for his wife and newborn. Because the only facility that is close by has no staff available and has been vandalised recently, it is not operational. Abud does not consider taking the trip to the nearest functioning health facility, as it is a long journey on a "boda boda" and a boat ride. It would cost too much money and the discomfort that they experience is not great.

Analysis

So what do these patient stories tell us about the challenges for caregivers throughout the health seeking pathway? In general, the slow onset of undernutrition leads to delayed health seeking behaviour. Unlike for example pneumonia, where the problem is acute and hard to ignore, for undernutrition the process is quite gradual, which results in there not being a moment early in the process where the problem seems urgent enough for caregivers to take the step to seek help.

"Let's say we have a mother at home, if the child is crying "my tummy is hotty" the mother will not have peace and not be enjoying herself and they will bring the child to the hospital. When it comes to malnutrition it is different. IT is slow at the onset and a bit of a nonissue until there is severe malnutrition such as oedema or flaky skin, that is when the mother will say that there is an issue and seek help." - Hospital nutritionist

Travelling to facilities with babies and infants is an extra challenge, as they are often carried on the back while walking or when taking a motorcycle or boat.

"With the babies I have to use transport and sometimes they are not available, sometimes I have money and sometimes I don't, if I have to carry it is on the back, sometimes on the side or on the front" - Caregiver

For undernutrition cases, follow-ups are often necessary to see if the situation of the infant has improved, but with the effort that it takes to get to a facility combined with the business of the lives of caregivers going back and forth to a facility is a real challenge. For more remote communities, this is an even bigger challenge. When talking to people in facilities, they were frustrated by their inability to reach out to patients whenever they were outside of the facility, which is especially relevant in the case of doing follow-ups. People might come into a facility with a health problem, get advice and treatment and are thereafter never seen again.On the other hand, for people in communities the facilities seem distant and often frustration was expressed in the (public) health system. People described that they travelled a long way only to be told that there was for example no treatment available.

"Coming back once a week [is important] to assess progress and counselling, counselling is very important to see what might still be going wrong. Some come back, others don't." - Hospital nutritionist

Caregivers expressed a lack of trust in the effectiveness of seeking help from facilities, especially from the public system, as they at times have long waiting times at facilities or there is an unavailability of treatment.

"For king fahad [hospital] we walk but you have to wait in a queue because many people go there, so you have to wait for my turn. Many times my wife goes there, she goes in the morning and then maybe she might be back at noon. When you go there there is free medica-

tion for the ones they have there and you get it for free, the other ones you have to buy." - Caregiver

For the different forms of undernutrition there are also specific challenges. For wasting, diagnosis is common and treatment is often possible and done through RUTF or RUSF. The treatment is done either inpatient or outpatient depending on severity. Stunting is underdiagnosed in facilities, this is because when stunting has occurred it is hard to do something about. For micronutrient deficiencies there are limited diagnostic capabilities. There is no blood testing so diagnosis is done on observing clinical symptoms. Many people are unaware of micronutrient deficiencies, so often no help is sought for it.

"Mostly what we are treating is wasting. Stunting is generally not treated, because you cannot do much about it once it is already there, some counselling might be done, [For the amount of micronutrient deficiencies] if there was some random check of blood sam-

ples, which are currently not done, it would be shocking " - Hospital nutritionist

6.5.2 Accessing healthcare

After empathising through the patient stories, we now look to explain, on a more systemic level, what causes these stories to contain many challenges when it comes to accessing healthcare for undernutrition. These are explained through the accessibility framework. The framework describes challenges around accessing healthcare through acceptability, affordability, availability, accessibility and accommodation. These five A's of access describe the five domains that are important in access to healthcare (Penchansky & Thomas, 1981; Wyszewianski, 2002)

   - Affordability refers to how the cost of healthcare services is related to the people's ability and willingness to pay for them
   - Availability refers to the extent to which the healthcare system has the necessary resources (such as personnel, tools and treatment) to provide services
   - Accessibility refers to how close healthcare services to the communities are geographically and how easy it is to reach them
   - Accommodation refers to how well the healthcare services are organised to meet the preferences of the people, such as opening hours, remote communication and flexibility in appointments
   - Acceptability refers to how comfortable the people are with the services provided, such as that they agree with cultural norms and values.

The filled in framework based on all the interviews can be found in figure 6.5. Based on the interviews, all five domains play a part in the limited accessibility to healthcare in Lamu, but accessibility, affordability and availability play the biggest role.

Accessibility

Boats and "boda boda's"

For some communities in Lamu, for example those that are living in the more populous urban centers on Lamu island, accessing a health facility is not the biggest challenge, as it might just be a (short) walk. For other communities however, such as those in the interior of the archipelago, the nearest operational health facility might be a long and expensive trip away. There is no guaranteed public means of transport in the region, and trips on the back of "boda boda's" (motorbikes) or on boats are often uncomfortable, long and prohibitively expensive.

Security concerns

Security concerns throughout the region, such as the presence of Al-Shabaab, further complicate the accessibility of facilities. Although the situation seems to have improved somewhat recently, it was mentioned in interviews as a reason for people to decide against going to the facility, especially if the case was not urgent.

"There are often lower-level facilities not too far from the communities, but facilities in some regions are nonfunctional due to security concerns, understaffing or no electricity etc."

"There is no guaranteed and public means of transporting between two islands"

Affordability

Cost of transport

When it comes to the problem of money to pay for health services there are two areas of concern; paying for transport to get to a health facility and in some cases paying for any necessary treatment. The cost of transport to the nearest facility or to a hospital in case of referral can quickly be so expensive that people might decide against going. A short boat or motorbike ride can quickly cost more than just a couple of dollars, in part due to the rising fuel prices. As people also have to pay for the return journey and most people in the region are facing a daily struggle of having enough money to pay for food and other necessities, the cost of transport is a big limiting factor in how much people get access to healthcare.

Cost of treatment

Secondly, there is a barrier for paying for the health services themselves. This is especially the case at private health facilities, where there is payment required for both the service itself as well as any treatment that is supplied. For the public system, often no payment is required for the health service themselves or for some treatment if it is available at the location. Often however, people end up having to go to a pharmacy and pay for some medication
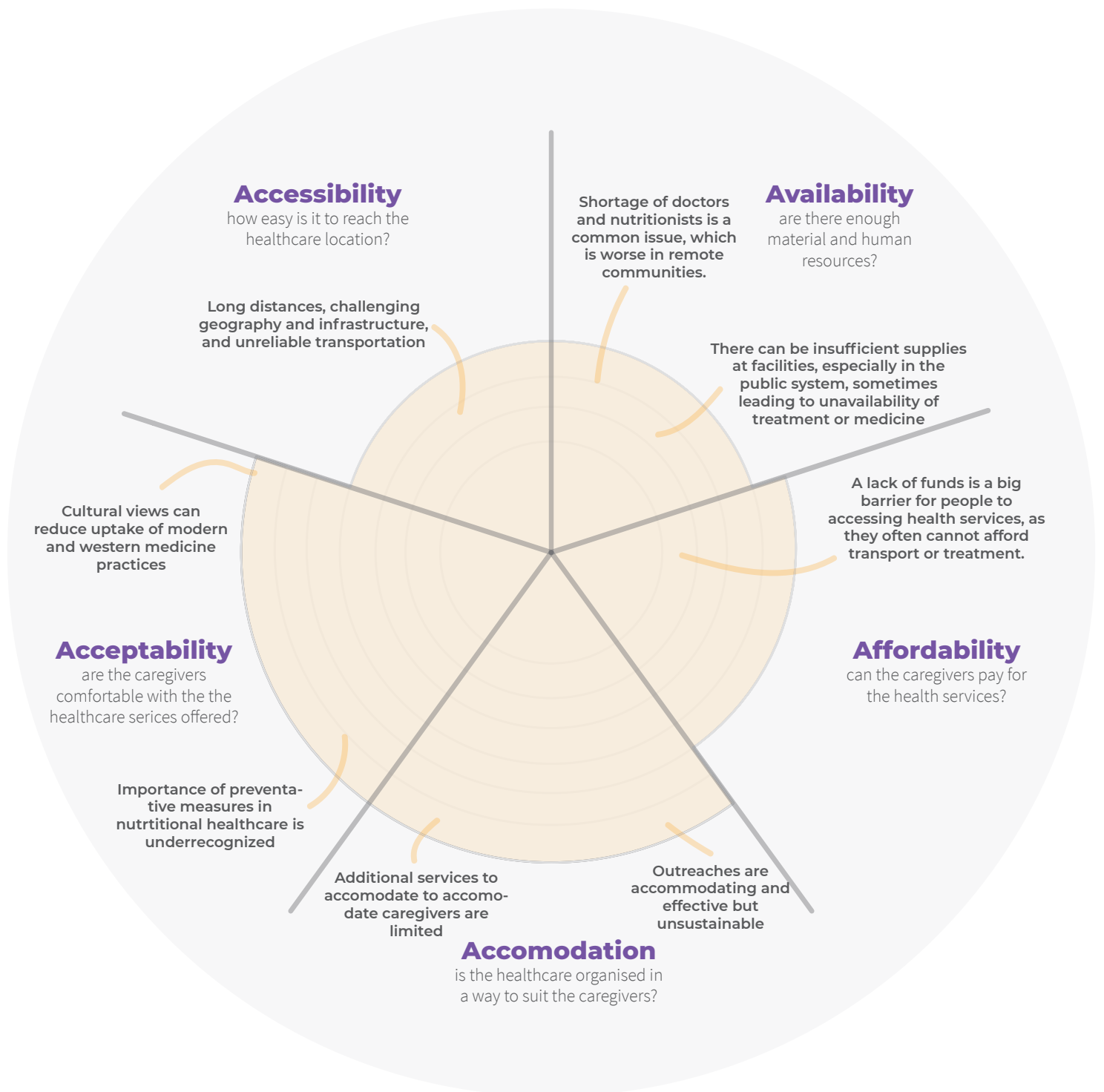
Accessibility
how easy is it to reach the
healthcare location?

Availability
are there enough
material and human
resources?

Long distances, challenging
geography and infrastructure,
and unreliable transportation

Shortage of doctors
and nutritionists is a
common issue, which
is worse in remote
communities.

There can be insufficient supplies
at facilities, especially in the
public system, sometimes
leading to unavailability of
treatment or medicine

Cultural views can
reduce uptake of modern
and western medicine
practices

A lack of funds is a big
barrier for people to
accessing health services, as
they often cannot afford
transport or treatment.

Acceptability
are the caregivers
comfortable with the the
healthcare serices offered?

Affordability
can the caregivers pay for
the health services?

Importance of preventa-
tive measures in
nutrtitional healthcare is
underrecognized

Additional services to
accomodate to accomo-
date caregivers are
limited

Outreaches are
accommodating and
effective but
unsustainable

Accomodation
is the healthcare organised in
a way to suit the caregivers?

Figure 6.5: Healthcare accessibility framework for Lamu. Less rings in a quadrant represents bigger related healthcare barriers.

themselves.

> *"Cost of transport is a barrier for people, the economy is hard, to come to facilities, this is a problem also for continuation of services"*

Availability

Material and personnel shortages

The health care system in Lamu, particularly the public sector, is facing a shortage of supplies, medicines, and personnel. This is due to various factors such as underfunding, safety concerns, and economic factors that make it difficult to attract personnel to work in remote facilities. The lack of supplies can lead to a negative perception of the public health system, as people may avoid seeking treatment if they have previously experienced a lack of available resources.

Missing diagnostic tools

Additionally, the availability of instruments, data, and diagnostic tools on a community level is limited. For example, there is currently an effort to provide all community health volunteers with a simple and affordable tool called MUAC tape, but even this is a challenge to fund. These limitations on tools and personnel make it difficult to gather nutritional data in the region.

Remote facilities have it harder

These problems are especially apparent in remote facilities, which face additional challenges due to security concerns and limited resources. It is also difficult to attract qualified personnel to work in these remote locations, which have few opportunities.

> *"Lately it [the treatment] is not available, for those communities that we found those cases, the facility personnel will tell you that they don't have anything to give."*

> *"Especially if they are in the interior, where you find that those services are not available."*

Acceptability

Strong cultural beliefs

Cultural factors have an influence on how comfortable caretakers are with health services that are offered. First, certain ritualistic beliefs stemming from a strong cultural identity may reduce the uptake of modern and western medicine practices. For example, beliefs that certain foods should be avoided during pregnancy and that additional foods should be fed to babies, while exclusive breastfeeding is recommended, may contribute to poor nutrition habits and scepticism towards health care services.

Nutritional health services underrecognized

A second influential cultural factor that limits the uptake of health services for nutrition particularly is the lack of recognition of the importance of growth monitoring. Caretakers do come into the facilities for vaccinations, as these are generally considered to be essential enough for caretakers to make the effort to come into the facilities, but this is not the case for growth monitoring.

Challenging social and economic dynamics

Lastly, a challenging economic situation and frequent social problems such as single mothers and drug and substance abuse in the population often makes it challenging for caretakers to manage their day-to-day lives. It is often a daily challenge to get enough money to buy the daily necessities and this pressure reduces the amount of headspace that people have to worry about whether they should take their child today to the facility to check on for example their nutritional status.

> *"The perception is that growth monitoring is not a big thing compared to vaccinations"*

Accommodation

Not set up for busy lives

In general, the health system is not particularly set up to accommodate the daily lives of the people it serves. Examples of this are that scheduled visits to facilities are sometimes forgotten as there is no system to send people reminders of when their visit is (a project doing this was set-up and proved effective, but was stopped when the partner organisation dropped out). Or that people have at times to stand in line before the facilities. Another example of this is that for every appointment people have to come to the facilities, with no remote communication in place.

Outreaches

There are initiatives and activities done to accommodate communities, such as outreaches (where teams of medical personnel travel to communities to do remote clinics). These are greatly appreciated by the communities, but are hard to fund as they are currently very resource intensive. Another aim of progress is to build on the system of CHV's in the region to give people in the communities a point-of-contact that is greatly accessible. Again a struggle for funding comes into play here though, as CHV's currently work on a volunteer basis and programs to train them are expensive.

"In areas where facilities are nunfunctional, people have to wait on outreaches from NGO's or facilities, doing remote clinics works but it is expensive and requires personnel to move around"

Fuel prices in Lamu have risen dramatically over the last couple of years, increasing the cost of transport on motorbikes and boats

6.6 Inequalities in health outcomes

In general, in interviews it was mentioned that the nutritional status of remote communities are likely worse than communities that live in more urban areas. Stunting was mentioned to be commonly seen in remote communities especially. This could be the result of various things. For one, remote communities experience the biggest barriers to healthcare, as they are often furthest removed from well equipped and operational health facilities. Second, remote communities often have lower general levels of education, which makes it more difficult to disseminate information on healthy nutrition habits and to increase awareness. Third, remote communities often have less resources and less food security than more urban areas, which puts them at a greater risk for unhealthy nutrition to start with.

Within communities there are also inequalities. Some families, which might have a lower socio-economic position and are therefore less able to afford proper nutrition or travel to facilities. They can be more occupied with making it through day by day so that there is little headspace left for visiting facilities for preventative meetings such as ANC visits or growth monitoring.

6.7 Chapter conclusions

To conclude, this section aimed to understand the local nutrition practices, what the touchpoints with healthcare facilities in the first 1000 days are, what it is like for caregivers to seek help in case of undernutrition, what the barriers are to healthcare that exist and what the resulting inequalities are in nutritional health outcomes in the region.

For problems concerning nutritional practices, people struggle to afford a balanced diet and often rely on cheap but nutritionally poor foods. There is also a lack of awareness on the importance of a varied and sufficient diet, and cultural superstitions can negatively affect dietary intake. Caregivers express that exclusive breastfeeding can be challenging, and food security has become an increasing problem due to unpredictable seasonal rains and global events. Additionally, many communities in Lamu do not have easy access to a clean water source.

There are regular contact points in the first 1000 days as caregivers are supposed to be seen for Antenatal Care (ANC) visits, delivery and postnatal care including vaccinations and growth monitoring. In practice, half of the caregivers are seen for ANC visits, caregivers do tend to come in for vaccinations as they are recognized as important but

growth monitoring less so.

For the health seeking pathway, nutrition often has delayed health seeking as the onset of symptoms is slow and gradual. Due to accessibility concerns and busy schedules, caregivers are even more inclined to put off a visit to a healthcare facility. When they do go to facilities, they often have to travel by walking, on the back of a motorbike or on a boat, all while carrying their child. For wasting, diagnosis and treatment is often available and possible. For micronutrient deficiencies, diagnosis is limited and supplements are sometimes available. For stunting, not much can be done about it and it is therefore often not diagnosed.

The issues for caregivers along the healthcare seeking pathway can be explained through the main issues for accessibility of healthcare. The most important of these are accessibility concerns (large distances, not many reliable transport options), availability concerns (supplies, medicines, and personnel), and affordability concerns (paying for transport and treatment (for private systems)).

All of this results in suboptimal nutritional health outcomes in the first 1000 days in Lamu communities, with the problems exacerbated for communities that are more remote.

6.7.1 Key takeaways for intervention design

Requirements:

Interventions should improve nutritional health outcomes in the first 1000 days and aim to reduce inequalities between and within communities

`Desirability`

Interventions that work with CHVs should compensate them for their efforts

`Viability`

Interventions should focus on the community level, as it is in line with the recommendations of the WHO to improve nutritional outcomes of young children and aligns with the national strategy

`Viability`

Opportunities:

Interventions could enable part of the health services to be taking place in communities, such as for initial initial nutritional diagnostics, nutritional follow-ups from facilities or growth monitoring

`Desirability`

Interventions could focus on early detection and prevention of undernutrition, especially for stunting

`Desirability`

Interventions could address food insecurity concerns

`Desirability`

Interventions could promote awareness and information on healthy nutrition practices within communities

`Desirability`

Interventions could leverage on the system of Community Health Volunteers (CHVs) to promote nutritional health outcomes on a community level

`Viability`
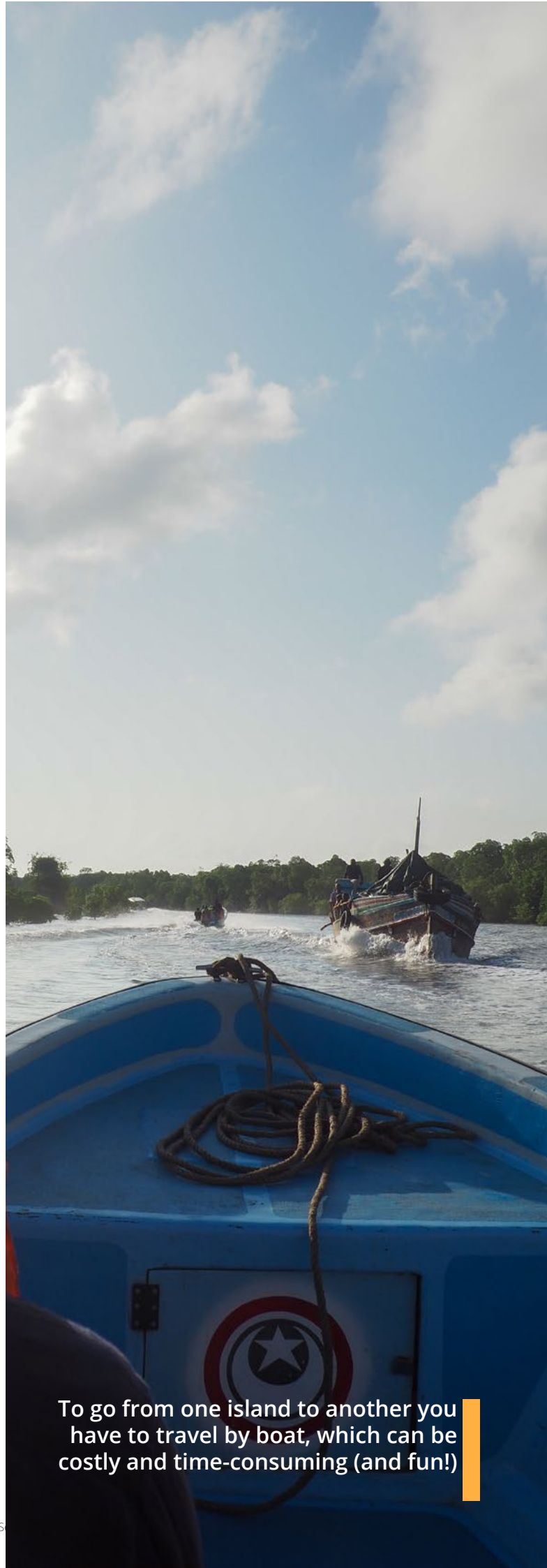
To go from one island to another you have to travel by boat, which can be costly and time-consuming (and fun!)

Chapter 7: Understanding Lamu technology

Now that the cultural and nutritional healthcare perspective have been considered, this chapter looks towards the technologies that are available that could provide opportunities for interventions.

7.1 Approach

Because there is the goal of using existing and available technologies to enable innovation in the context of (un)healthy nutrition, this chapter explores how technologies are generally used to facilitate innovation in the sub-Saharan context, which tools and technologies could be used in the context of (un)healthy nutrition, and how technologies in general are currently used in Lamu.

To form this understanding, first literature and desk research are used to understand how technologies are generally used to facilitate innovation in the sub-Saharan context and which tools and technologies could be used in the context of (un)healthy nutrition. Next, interviews and observations during the fieldwork understand how and which technologies are currently used by communities in Lamu.

7.1.1 Chapter research questions

- How are technologies used in the local context of (un)healthy nutrition and in the local society in general?

- How are tools and technologies used to innovate in healthcare in sub-Saharan African countries?

- What tools and technologies can be used for undernutrition?

- Which tools and technologies for undernutrition are already used in Lamu?

- What products and technologies are used in Lamu in general?

7.2 Technologies and innovation for healthcare in sub-Saharan contexts

Telemedicine in Ghana

The Ghana telemedicine program connects frontline community health workers to medical specialists via 24-hour teleconsultation centres using simple phone calls. It empowers community health workers, improves quality of care, and reduces transport times and costs for patients. Due to its success, the Ghana Health Service selected the program for nationwide implementation in 2016. (Ghana Telemedicine, n.d.)

Whatsapp for maternal health in South-Africa

MomConnect aims to support caregivers during and after pregnancy with weekly SMS/WhatsApp messages continuing until the baby's first birthday. It gives information to promote maternal and infant health. A helpdesk function uses machine learning to address frequently asked questions and the platform receives between 1000 and 7000 messages a day (MomConnect, n.d.).

Figure 7.1 : innovation in healthcare across sub-Saharan Africa

SMS-based health data in Uganda

mTrac is a system used by health facility workers in Uganda to submit routine health surveillance data via SMS using their own basic mobile phones. The system includes a digital platform for collecting and analysing facility and community health management information data. Through the system notifiable diseases, stock levels for eight tracer medicines, and maternal and neonatal deaths are tracked and automatically integrated into a system for analysis. The eHMIS system has a database of over 62,000 health workers' mobile phone numbers, which allows local government to communicate with health workers and empower district health teams with information and tools for timely response. (MTrac, n.d.)
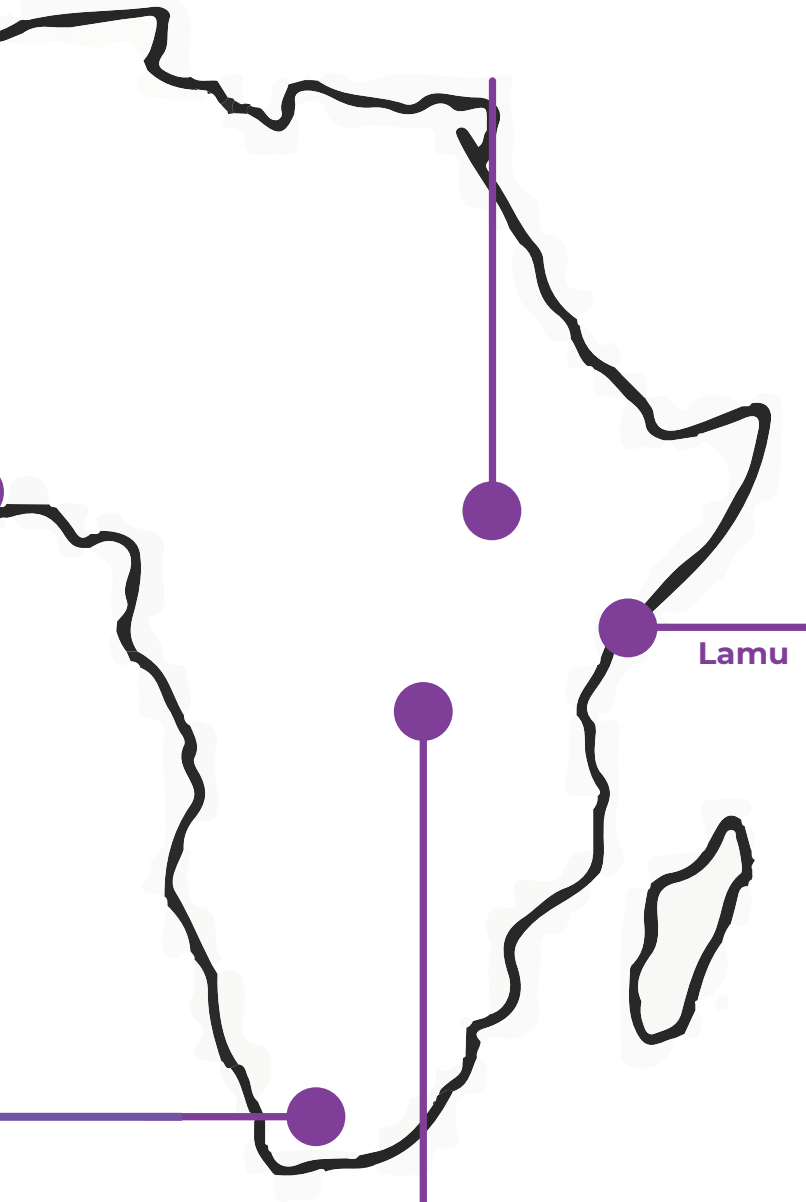
Lamu

Telemedicine in Lamu

A telemedicine programme aimed at connecting and treating children called Daktari Smart was started in Lamu. It targets over 32,000 children across Lamu, Samburu, Homabay, and Baringo. It uses electronic medical devices such as an electronic stethoscope, an ultrasound machine, and an electrocardiogram combined with video-call smartphones to enable remote county health facilities to access medical specialists to attend to patients. The initiative aims to reduce the number of referrals of sick children by and will optimise the capacity and reach of healthcare delivery systems in Lamu.

Reminding of vaccinations and due dates in Lamu

A mobile health program launched in 2018 has been using phone notifications to remind Community Health Volunteers (CHVs) of maternal and child health appointments. The CHVs are equipped with smartphones that alert them when pregnant women within their cluster are due for a skilled delivery at the hospital or when their children are due for immunizations. (Kahenda, 2022)

Drone deliveries for blood transfusions in Rwanda

Zipline is a company that uses drone delivery services to quickly stock up remote healthcare locations that need blood. Traditionally, remote hospitals in the East African country had to rely on road transport, but that could result in spoilage of certain blood components such as platelets. Overstocking was therefore common in rural facilities, leading to wasted supplies. After the government signed a deal with Zipline in 2016, two hubs were set up, each capable of delivering up to 500 parcels a day.

7.2.1 Analysis of typical technological innovation in sub-Saharan African countries for healthcare

Technology can be used to overcome geographical barriers, making it a valuable tool for interventions that aim to connect people who are physically far apart. Even simple technologies like SMS messaging can enable innovation and be used to disseminate information about healthy practices or send reminders. Thus, interventions can be designed to either overcome barriers, provide information or to send reminders depending on the intended goal. Technologies used for innovation in sub-Saharan African contexts are often frugal and low-cost, as funds are limited in the context.

7.3 Tools and technologies for undernutrition

As seen in chapter three, healthy nutrition for Lamu has the most potential for technology to step in with diagnostic tools, as they are simple and could therefore be applicable to a community level context. These tools are used for anthropometric measurements such as weight, height or recumbent length and MUAC.

To measure weight in the first stages of life, there are three options, hanging weighing scales, standing weighing scales and weighing scales in which infants can lie down. For standing weighing scales, some come with the option for doing two measurements easily, so that children can be measured while being held by a parent, see figure 7.2.

There is a difference between length and height when it comes to measurements. Recumbent length is taken with the infant lying down, and measures from the top of the head to the soles of the feet. Height is taken standing up and measured from the top of the head to the plane that is stood upon. (Gripp et al., 2013).

Length is measured lying down using a stadiometer, a measuring board or rollable mats, using measuring tape or a stadiometer. Height is measured using wooden boards, measuring tape, stadiometer etc., see figure 7.3.

Products that combine measuring weight and height in one product exist, see figure 7.4.

For MUAC measurements, MUAC-tape (see figure 7.5) has been widely adopted across sub-Saharan Africa and works well on a community level. The colour indications help in making results easy to interpret.The colours on the tape indicate the severity of malnutrition and makes it easy to see what steps need to be taken. If the score is red, referral to a facility is urgently needed. For yellow, consultation with a CHV might be enough. Green indicates a healthy child.

Figure 7.2 : To measure weight for young children, various weighing scales can be used both digital and analogue can be used

Figure 7.3 Height or recumbent length can be measured using a variety of products

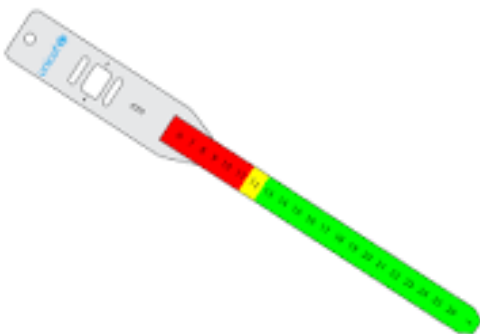*Figure 7.4: products exist that combine both length and weight measuring for infants*

Figure 7.5: to measure Middle Upper Arm Circumference (MUAC), MUAC tape is used

7.4 Nutritional diagnostic tools in Lamu

In all facilities that were seen during the fieldwork weighing scales, height measuring mats and boards and MUAC-tape was present see figure x. There were no indications in the interviews that there was a problem with these diagnostic tools at the facility level.

When talking to the CHVs and asking other stake-holders about the use of these tools on a community level it became clear that most of these tools are not used within communities. MUAC-tape is currently being supplied to CHVs for them to do basic referral in cases of wasting, but height and weight measurement tools are currently not available in communities.

NGOs and health facilities, while doing outreaches, take these diagnostic tools with them into communities.
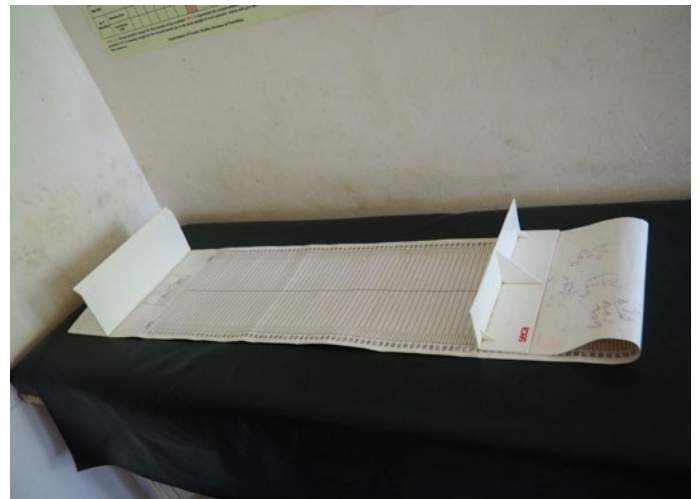
Figure 7.6: the various anthropometric measuring devices seen in facilities during the fieldwork, MUAC-tape was present but not pictured here

7.5 Nutritional data in Lamu

7.5.1 Documentation of data in facilities

The documentation of health data in facilities is currently primarily done on paper. On a monthly basis, the data that has been collected in books is converted to the national digital system. There are some challenges with regards to physical data documentation. It poses a risk of data loss if a booklet is misplaced. Furthermore physical documentation is time-consuming, which can lead to delays in data analysis and reporting.

While digital data storage could potentially address these issues, there are several barriers. In some parts of the healthcare system computers may not be widely available, as is the case in some parts of Kenya, which makes the full switch to a digital method of working difficult. Second, altering any system that handles privacy-sensitive data can be difficult and expensive. Data documentation and analysis should comply with national regulations, which can be strict and therefore make it difficult for digital data systems to be introduced.

Figure x: Data documentation is mainly done on paper, and is manually digitized on a monthly basis in the national system

7.5.2 Gaps in nutritional data

The availability of nutritional data on community level is limited. The most recent nutritional survey with comprehensive data throughout the county dates back to ten years ago. The availability and accuracy of nutritional data outside the health facilities presents significant challenges to communities and the healthcare delivery system. Firstly, there is no exchange of data between communities and NGOs/facilities, making it impossible to follow or contact patients outside of facilities. Moreover, the current data collected in facilities is limited in its representation since it only captures a small subset of the patient population. This limitation is particularly relevant when it comes to stunting, which is especially underdiagnosed at the facility level.

"For Lamu, the number one thing is that we have a gap deficit in terms of information and research. We still have huge gaps [in data], for example 2018 there was a survey done on nutrition because by that

time the country was experiencing huge droughts, when it was done we had stunting around 14 percent and since then we haven't had any exhaustive survey to give information on where we are." - Hospital nutritionist

The exclusive collection of data at facilities means that more remote communities are the least understood when it comes to nutritional issues. This data inequality is a significant concern for these communities, which often have significant barriers to accessing operational health facilities. As a result, the extent and details of nutritional problems in these areas are unknown, and there is a lack of comprehensive nutritional data to guide health interventions. This data gap can exacerbate existing health inequalities, as communities that are already marginalised may be further disadvantaged due to a lack of support.

"But on a community level they could check for it. There you get the primary data, in that sense the community level is more powerful. It brings you close to those people you are targeting. If you target the facility there are many people who cannot access it, people might see a visit to the facility as time wasting or it is difficult to access because of costs. They can shy off of the facilities. , But if it is at the community level, that is different, so it is key." - NGO

7.6 Technologies used in Lamu communities in general

What stood out most during the fieldwork concerning technology use in Lamu was the adoption of (smart)phones. Phone use is widespread, and the network coverage is extensive throughout the region. Despite the prevalence of smartphones, feature phones are also still common. Some remote communities may not have access to the phone network. Smartphones are particularly in urban areas of Lamu, with many people owning one. Social media use is widespread as they use it to connect and share online. One caregiver expressed that she preferred buying phone data over food at times.

"Yes I have a smartphone. We better stay hungry than not have a smartphone. I tell you the truth here haha! You make sacrifices, sometimes I prefer to not eat but I buy airtime (phone data)" - Caregiver

Another caregiver explained how they are able to afford phones:

"We have smartphones, a lot of people have them. The Chinese are the ones who made these changes, the Chinese made them cheap, they made them according to our pocket, there are expensive ones, but there are also cheap ones." - Caregiver

Voice calling is the most common mode of communication and is preferred over messaging platforms like WhatsApp or SMS.

A notable example of how technology has been adopted in Lamu is the widespread use of M-Pesa, a phone-based money transfer service that allows for easy payment from SIM card to SIM card. M-Pesa is compatible with both smartphones and feature phones and serves as an excellent example of how technology can be adapted to meet the needs of local communities.

Both smartphones and feature phones are ingrained in the day to day lives in Lamu

7.7 Chapter conclusions

This chapter dived into the technological aspect of healthy nutrition in sub-Saharan Africa and Lamu.

Innovation within health in sub-Saharan Africa often involves bridging large distances through communication technology, either to provide information to communities directly or to connect communities to healthcare workers remotely.

Anthropometric measurement tools are reported to be present and functioning well in the facilities, according to interviews with healthcare workers. However, it is noted that these tools are not widely used on a community level, with only MUAC-tape being supplied to community health volunteers for basic referral in cases of wasting.

Data documentation in facilities is mainly done on paper and manually digitised on a monthly basis. Digital data storage could potentially address these issues, but there are barriers to changing such systems. There is a significant lack of nutritional data on the community level, which presents challenges to communities and the healthcare delivery system, particularly for more remote areas where data is exclusive to facilities. This data gap can exacerbate existing health inequalities.

The fieldwork conducted in Lamu highlighted the widespread adoption of smartphones, feature phones, and the extensive network coverage throughout the region. Social media use is prevalent, and voice calling is preferred over messaging platforms. M-Pesa, a phone-based money transfer service compatible with smartphones and feature phones, is widely used and serves as an example of how technology can be adapted to meet the needs of local communities.

7.7.1 Key takeaways for interventions

Requirements:

Interventions should make use of low-cost technologies and be affordable in implementation `Viability`

Interventions that gather nutritional data should comply with national regulations `Feasibility`

Opportunities:

Interventions could focus on using technology to bridge barriers to accessing healthcare `Desirability`

Interventions could focus on providing information on healthy practices or on sending reminders `Desirability`

Interventions could make use of simple communication technologies such as sending messages via SMS `Feasibility`

Interventions could focus on making anthropometric measurement tools available on a community level, as they are currently only available within facilities `Feasibility`

Interventions could make use of (smart)phones, as they are widely adopted in Lamu `Feasibility`

Interventions could focus on gathering inclusive and accurate community nutritional data, as this is currently not available which can contribute to inequalities `Desirability`

SECTION 4

// Designing interventions //

Chapter 8: Opportunities for technology driven interventions
Chapter 9: Implementation scenarios
Chapter 10: Intervention evaluation

After understanding the local current context, this section builds on the insights from the previous section and looks towards the future. It explores how nutritional health in the first 1000 days could be improved by ideating, concepting and evaluating different intervention scenarios.

Chapter 8: Opportunities for technology driven interventions

After gaining a good understanding of the local healthcare, culture, use of technology and the medical background of (un)healthy nutrition, it is now time to look toward the future. Where are the opportunities for available technology to answer some of the local problems that have been found? In the first chapter of this section the insights from the previous section are synthesised into building blocks that can be used going forward for the intervention design.

8.1 Approach

In this chapter we first summarise the insights of this section in an overview of the context and revise the project goal. Next, we convert the insights that were found in the previous section into opportunities for technology driven interventions. This is done by looking at the unknowns of the intervention, in the form of the who, how, what, where, why and when. The insights from the previous section form a good basis for some of these unknowns, especially for the "who" (CHVs are promising to focus on) and the "what" (which technologies are available that present opportunities), and the "how" (the technological enablers in the form of the anthropometric measurement tools and (smart)phones). A session with CHVs was held with two purposes. The first was to evaluate the basics of supplying them with anthropometric measurement tools and combining them with smartphones to carry out measurements on infants in their communities. The second was to co-create and explore some further unknowns, such as the where and the when. These insights combine to form the "puzzle pieces" that are used in the next chapter to devise different intervention scenarios, see figure 8.1.

8.1.1 Chapter research questions

- What are the opportunities from the context research for technology-driven interventions and how could they improve on nutritional health outcomes in Lamu in the first 1000 days?

  - Where, based on the context research, could interventions improve on local nutritional health outcomes in the first 1000 days?

  - How, based on the technology research, could interventions improve on local nutritional health outcomes in the first 1000 days?

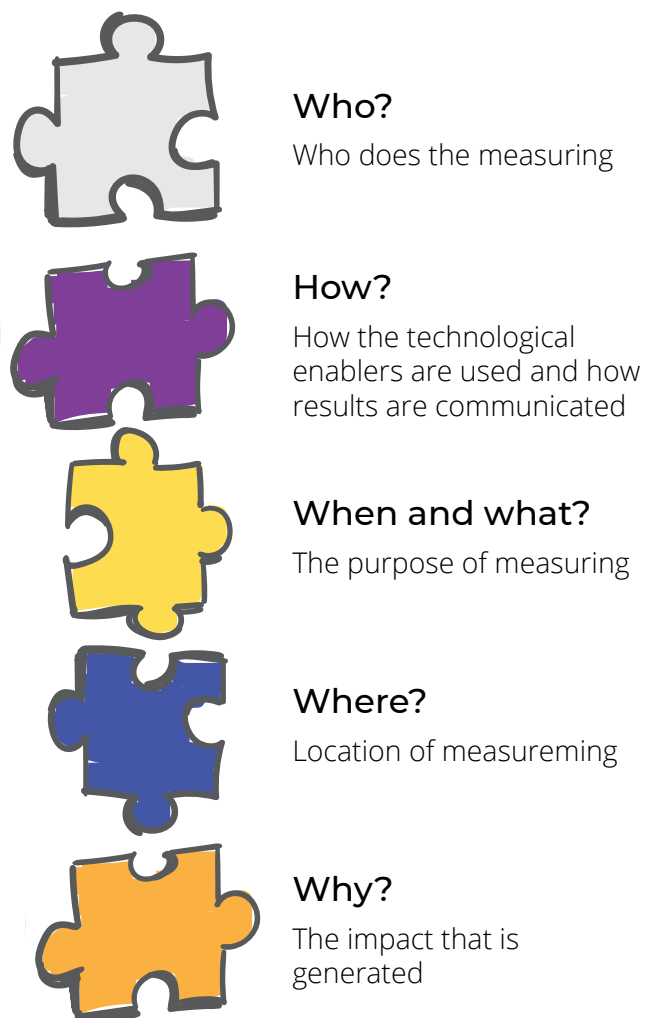 - How can the opportunities combine in an intervention (product-service-system)?

Who?
Who does the measuring

How?
How the technological enablers are used and how results are communicated

When and what?
The purpose of measuring

Where?
Location of measureming

Why?
The impact that is generated

Figure 8.1: the various "puzzle pieces" that are the variables for the to be designed intervention

8.2 Overview of context

Combining the different aspects from the insights of the previous chapter in this section, we can summarise the current context around nutritional health in the first 1000 days in Lamu communities, an overview is presented in figure 8.2. To start, there are many opportunities found. Communities in Lamu have a strong social cohesion and rely on informal networks to help each other out. The CHVs are an extension of this, and is an approach that leverages on the strong communities. Furthermore, (smart)phone use is ubiquitous in communities in Lamu, which could open up the door for new interventions. Finally, for nutrition specifically, diagnostic tools in the form of anthropometric measurement tools are simple and effective, and could provide opportunities for communities.

On the other hand, there are various challenges facing communities. First, people in communities often experience challenging lives, as a lack of stable economic opportunities mean that many families have to struggle on a daily basis to provide enough food. Social issues, such as safety concerns and substance abuse that exist in the area add to this problem. At the same time, the communities experience various barriers to accessing healthcare. The busy daily occupation of the day to day lives of caregivers combined with the barriers to healthcare can lead caregivers to putting off visits to healthcare facilities for preventative measures (such as ANC, growth monitoring and vaccination) or diagnostic purposes (in case of undernutrition diagnosis or follow-ups). This is even worse for nutritional related healthcare, as the onset of symptoms is often slow and gradual. All of these issues are often worse for remote communities, as they face more challenges and experience the biggest barriers to healthcare. Together, this leads to suboptimal and unequal health nutritional health outcomes.
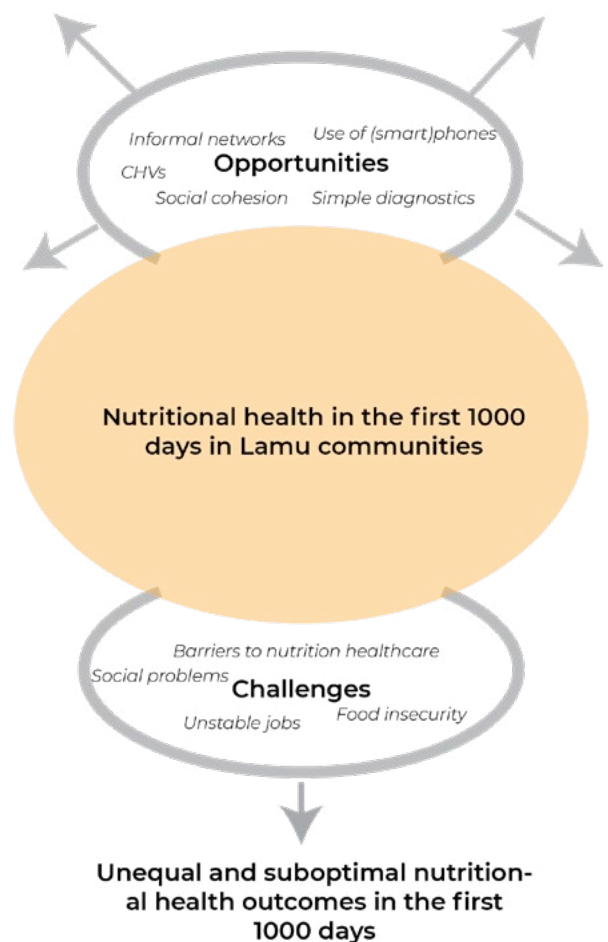

Figure 8.2: current context overview
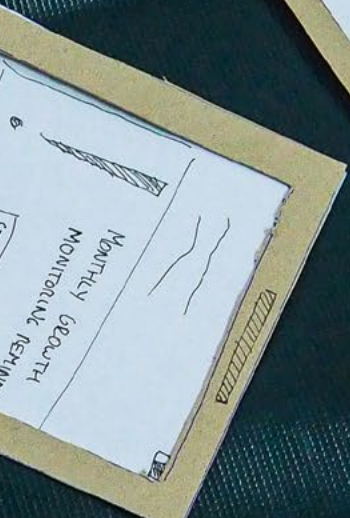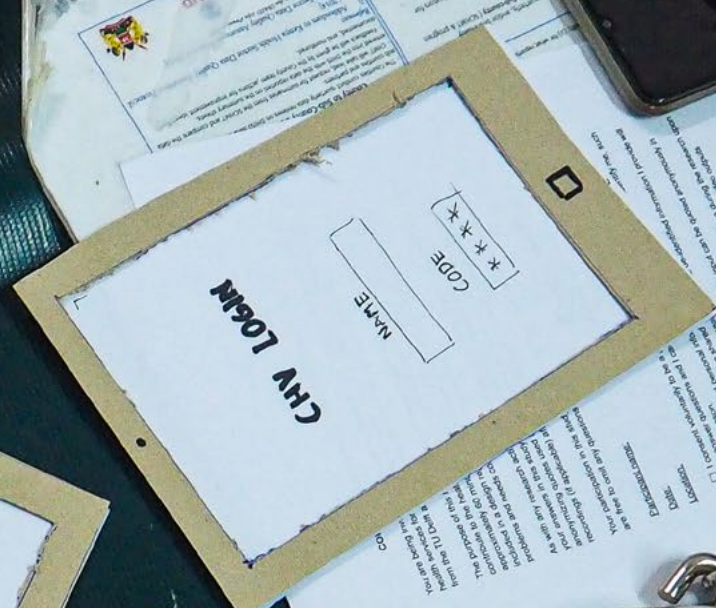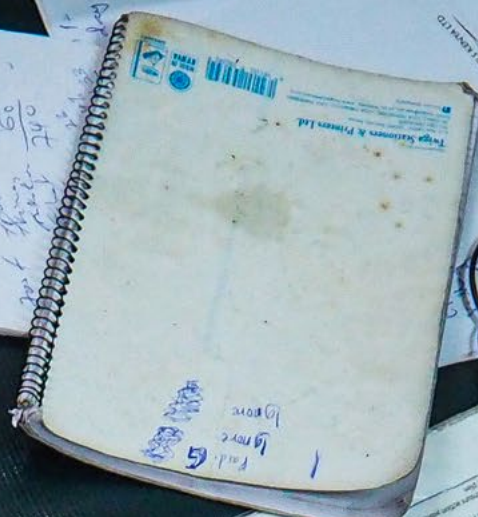
8.3 Defined project goal

Based on the insights gathered around the challenges and opportunities for nutritional health in the first 1000 days in communities in Lamu, we want to promote nutritional health services in the first 1000 days on a community level. This would circumvent the barriers that currently exist in accessing services in facilities, accommodate caregivers in their challenging lives, and could play a role in prevention or early diagnostics of any nutritional problems, therefore improving nutritional health outcomes and reducing inequalities. The main opportunities to promote nutritional health on a community level comes from the technological enablers, through simple diagnostic tools and the use of (smart)phones, and the strong and informal social structures within communities of which the CHV is an important part in this context.

We want to enable prevention and early stage diagnostics of undernutrition for infants in the first two years of life in Lamu communities through community-based diagnostics and communication technologies by leveraging on the system of CHVs.

8.4 Opportunities for interventions

8.4.1 CHVs (who)

CHVs are in the best position to use the technological enablers to conduct the basic nutritional health services on a community level for various reasons. CHVs have basic medical training and are literate. They are already active to improve the health of young children in their communities, and leveraging their position is in line with the nationally deployed strategy. From the cultural community perspective, CHVs know their communities well. They are strongly embedded in the informal structures of the communities and have strong relationships with the people in the community that they serve. Furthermore, supplying and training of CHVs for interventions is cost-effective, especially compared to doing it on a family level.

CHVs reacted positively in the session to the suggestion of putting them central in interventions that promote nutritional health in their communities. In interviews, when discussing a potential increased role for CHVs, it was often mentioned that they should be fairly compensated and motivated, this is discussed in more detail in chapter 10.x

CHV are a non-variable puzzle piece for the intervention design that follows
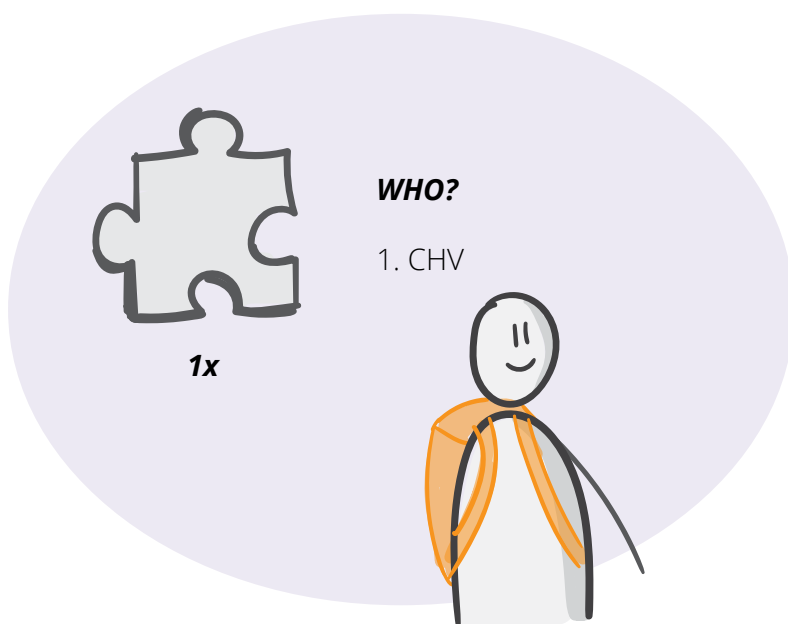
8.4.2 Technological enablers for community-based measurements (how)

From the initial goal it was defined that the intervention should make use of available technologies. The previous section showed that (smart)phones and anthropometric measurement tools are available. The anthropometric measurement tools, which are crucial in prevention and early stage diagnostics of undernutrition, are simple and effective, and therefore could present an opportunity to be used on a community level. Smartphones are widely used in the context and can, when combined with the anthropometric measurement tools, store and communicate the measurements to various stakeholders. The data could be owned by different groups of stakeholders, from caregivers themselves to the facility level, which could have different impacts.
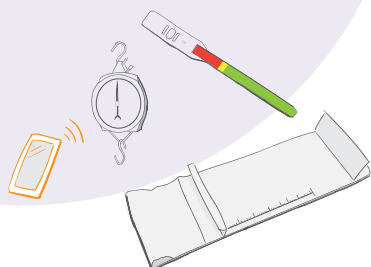

WHO?

1. CHV

1x

6x
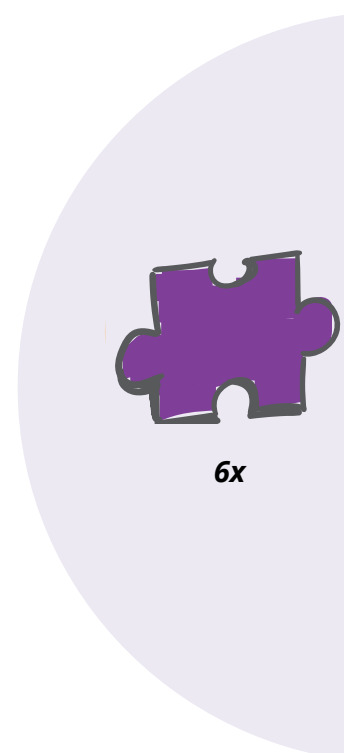
8.4.3 Various possible community-based nutritional health measurements (what and when)

By combining the diagnostic tools and smart-phones, various preventative and early stage diagnostics for undernutrition could be enabled. Growth monitoring, which is currently only sparingly done on facility level, could be done more widespread and effective on a community level. Early stage diagnostics of wasting and stunting could be done on the community level. As this would take away the main barriers that exist in accessing healthcare, it would combat the late healthcare seeking behaviour that exists for undernutrition. Follow-ups for wasting and stunting could be enabled, connecting health facility nutritionists with caregivers remotely and reducing the amount of times that caregivers have to travel back and forth to facilities. The "when" of the intervention is linked to the goal of the measurement that is done. For growth monitoring for example, this would be on a monthly basis in the first years of life, whereas undernutrition diagnostics are done when a caregiver or CHV deems it necessary.

WHAT AND WHEN?

1. Growth monitoring
2. Early stage diagnosis of stunting and wasting
3. Follow-ups for stunting and wasting
4. Nutritional surveys

4x

HOW?
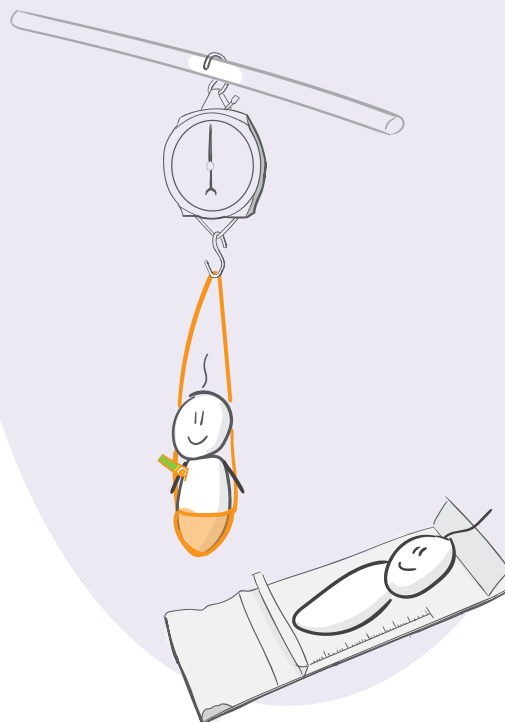
1. Weight measurement
2. Height/length measurement
3. MUAC measurements,
4. Phone documentation,
5. Phone communication
6. Data analysis

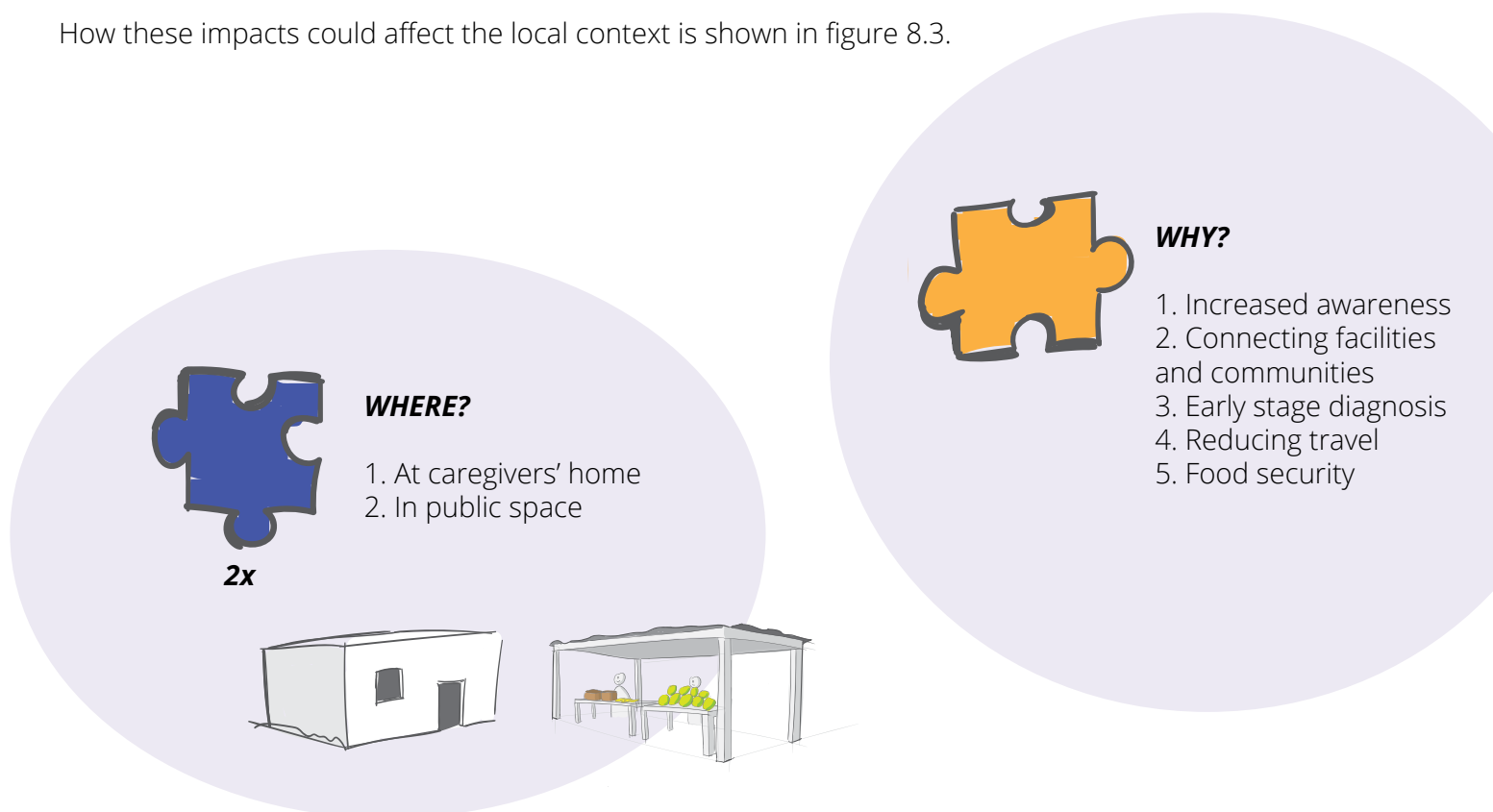## 8.4.4 Various locations for doing measurements (where)

There are two main obvious locations where caregivers with young infants in the first years of life can be found, at home or in a public space such as a market. Other options, such as at schools, would be promising but are not suitable in the first years of life. CHVs expressed in the co-creative session that they would prefer going to caregivers at their house, as they felt that caregivers would probably not regularly show up if they were asked to come to a different location.

8.4.5 Various forms of impact (why)

Community-based nutritional health services could improve the starting position to life when it comes to nutrition in Lamu communities. The overarching impact of all of these impacts would be to reduce inequalities within and between communities. Opportunities for impact to improve nutritional health of infants across Lamu are present in the the following ways, based on the understanding of the context in the previous section:

1: **Increased awareness** on the importance of nutrition in the first stages of life and what a healthy diet is for infants could prevent undernutrition

2: **Connecting facilities and communities** through remote communication would make it easier for nutritionists to follow-up on undernutrition cases

3: **Early stage diagnosis** for stunting and wasting would catch problems early, which improves treatment outcomes

4: **Reducing travel** for caregivers so they have to travel back and forth to facilities less, which improves the wasting and stunting health seeking journey

5: Improving **food security** of communities and families that are unable to afford or obtain a sufficient and varied diet

How these impacts could affect the local context is shown in figure 8.3.
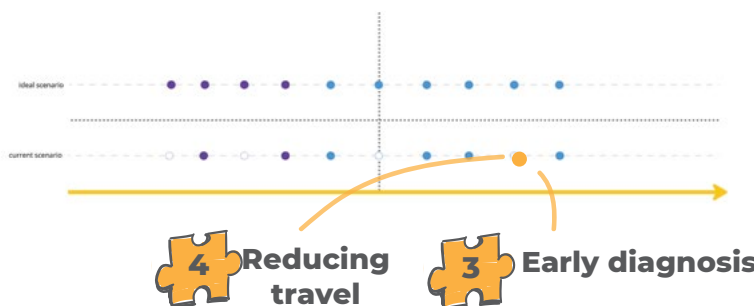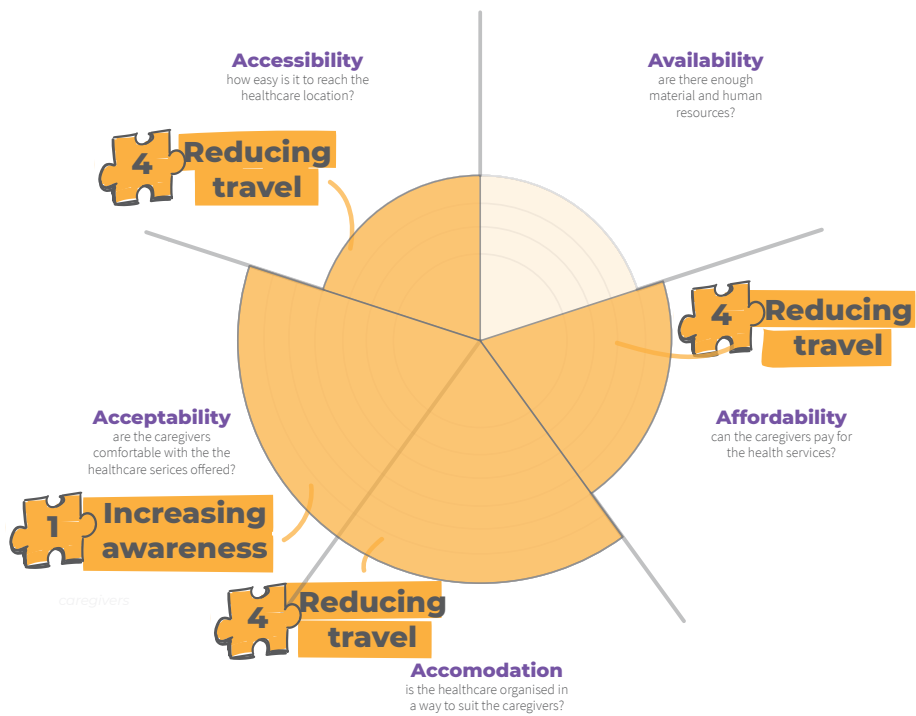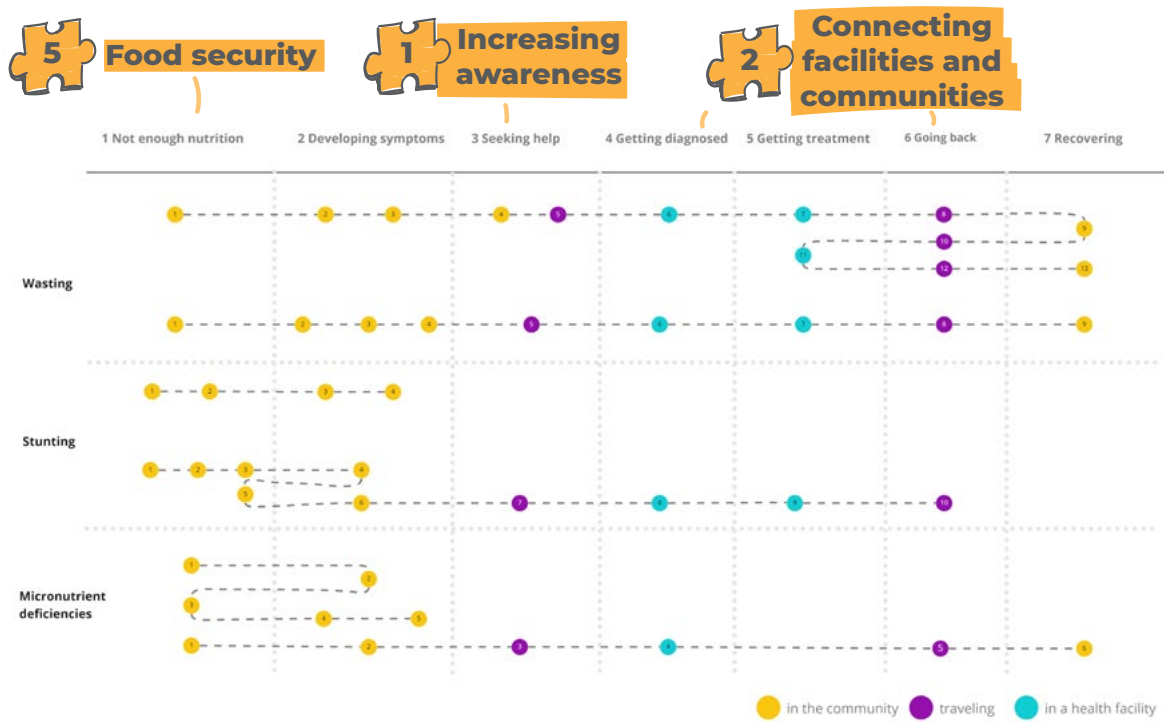

WHERE?

1. At caregivers' home
2. In public space

2x

WHY?

1. Increased awareness
2. Connecting facilities and communities
3. Early stage diagnosis
4. Reducing travel
5. Food security

5 Food security

1 Increasing awareness

2 Connecting facilities and communities

1 Not enough nutrition   2 Developing symptoms   3 Seeking help   4 Getting diagnosed   5 Getting treatment   6 Going back   7 Recovering

Wasting

Stunting

Micronutrient deficiencies

in the community   traveling   in a health facility

Accessibility
how easy is it to reach the healthcare location?

Availability
are there enough material and human resources?

4 Reducing travel

4 Reducing travel

Acceptability
are the caregivers comfortable with the the healthcare serices offered?

Affordability
can the caregivers pay for the health services?

1 Increasing awareness

caregivers

4 Reducing travel

Accomodation
is the healthcare organised in a way to suit the caregivers?

ideal scenario

current scenario

4 Reducing travel

3 Early diagnosis

Figure 8.3: where impact could be made on the system

8.5 Combining opportunities

In short, by supplying CHVs with anthropometric measurement tools and (smart)phones, they could measure the weight, length and height of young infants in their community and easily store and communicate the measurements to relevant stakeholders. In this way, basic preventative nutritional health services in the first 1000 days could be offered on a community level. This is visualized in figure

Nutritional health is especially suitable for doing things at a community level, as the diagnostic tools for nutrition are simple and effective. This is especially so for wasting, stunting and growth monitoring. Furthermore, as (smart)phones are widespread in the context they could be leveraged on to effectively document and communicate outcomes.

Community based interventions would improve nutritional health outcomes in the first 1000 days and reduce inequality. By moving the location of nutritional health services to the community level instead of at the facility level, some of the main barriers that care-givers experience when trying to access healthcare services, such as paying for transport and long travel times, are taken away. This is especially relevant for communities that are more remote and further away from facilities, therefore reducing inequality. By providing nutritional health services close to home, diagnosis and prevention of any problems when it comes to nutritional health can be done at an early stage, which both improves any treatment outcomes and reduces costs.
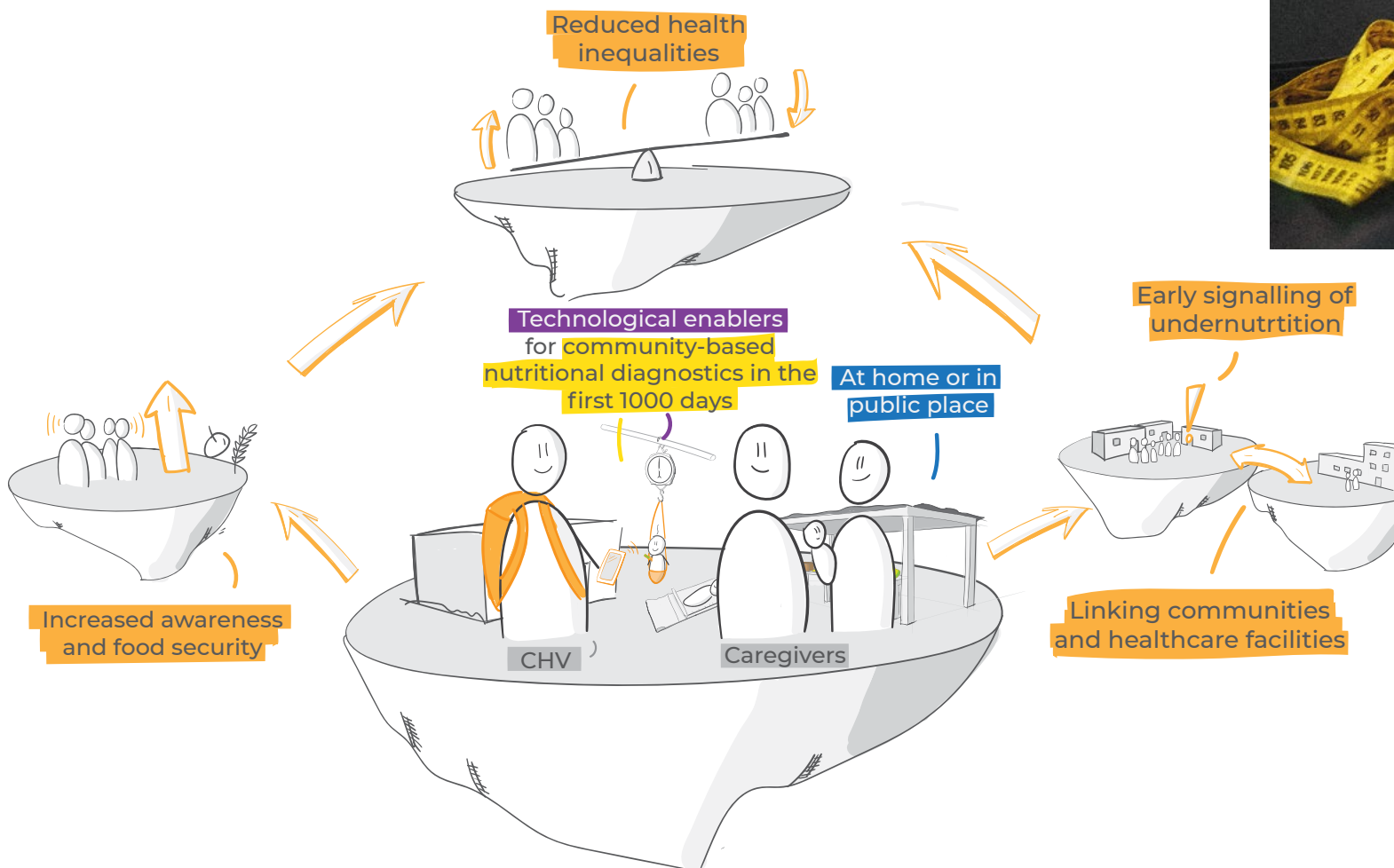

Figure 8.4: overview of the basic system of the intervention, orange arrows indicate the impact that could be generated

Evaluating and co-creating with a CHV

8.6 Evaluation + co-creation

The basics of the proposed intervention were evaluated and co-created in a session with two CHVs. Details of this session can be found in appendix A.3.4..

The results of this session were that CHVs are suitable to carry out the measurements in their communities, as they are both capable of using the tools and enthousiastic about the prospect. They prefer going to where caregivers are, such as public spaces or at their house, rather than let caregivers come to their house, as they doubt that caregivers would come Using the measurement tools and documenting the data on phones is feasible. Interaction with the phone interface should be simple and visual. Identification of infants is done via personal description or another solution has to be found.

8.8 Opportunity for redesigned anthropometric measurement tools

In the fieldwork interviews, preferences for various types of anthropometric tools for use in communities were asked appendix A.3.1. The outcome was that current measurement tools are often not ideally suited for existing within communities, as they are either not easy to use, not easy to read, inaccurate or reliant on batteries. This led to the insight that there is an opportunity to redesign these tools into an integrated solution that is suited to exist on a community level that can measure the length, height and weight of young children and allows for easy data storage. The details of the design requirements that were obtained from the interviews can be found in appendix A.3.1. In general, the ideal device for doing anthropometric measurements in the first years of life would combine doing the various measurements, be robust, easy to read, portable, not reliant on a power grid or batteries and more. An impression of what such a redesigned infant measurement device could look like is presented in figure 8.5.
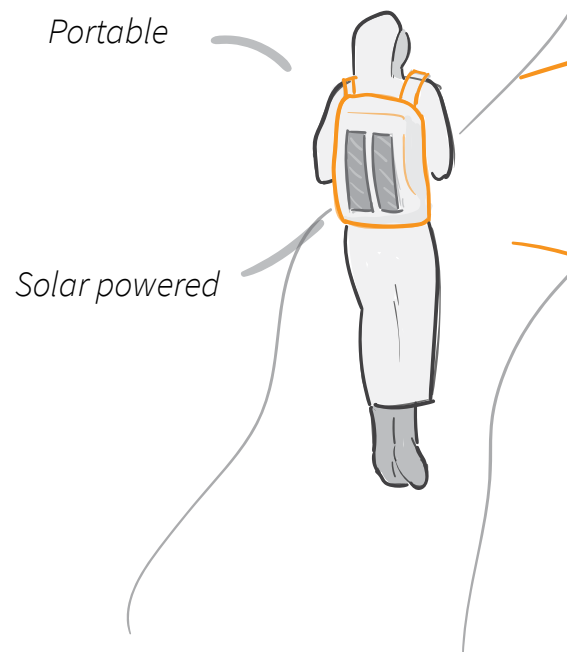
8.9 Chapter conclusions

This chapter converted the insights from the context and technology research of section 3 into opportunities for interventions. It did this by looking at the what, when, where, why, and how of interventions that could enable basic nutritional health services in the first 1000 days on a community level. CHVs are central to these interventions, as well as the technological enablers that were found in the form of anthropometric measurement tools and (smart)phones. A co-creative session with two CHVs was held to both evaluate and explore the basic principle of supplying CHVs with the technological enablers to carry out nutritional health services in their community. The results were positive, and gave insight on where and how measurements could be carried out and documented. Furthermore, an opportunity was described for redesigning the various anthropometric measurement tools in an integrated product that is designed to exist on a community level.

8.9.1 Key takeaways for interventions

As no new research insights are present in this chapter, no new requirements and wishes stem from this chapter. There are however some key takeaways:

- Interventions could supply CHVs with anthropometric measurement tools and (smart)phones to enable basic nutritional health services in the first 1000 days on a community level.

- Anthropometric measurement tools could be redesigned into an integrated product that is suited to exist within communities and be used by CHVs
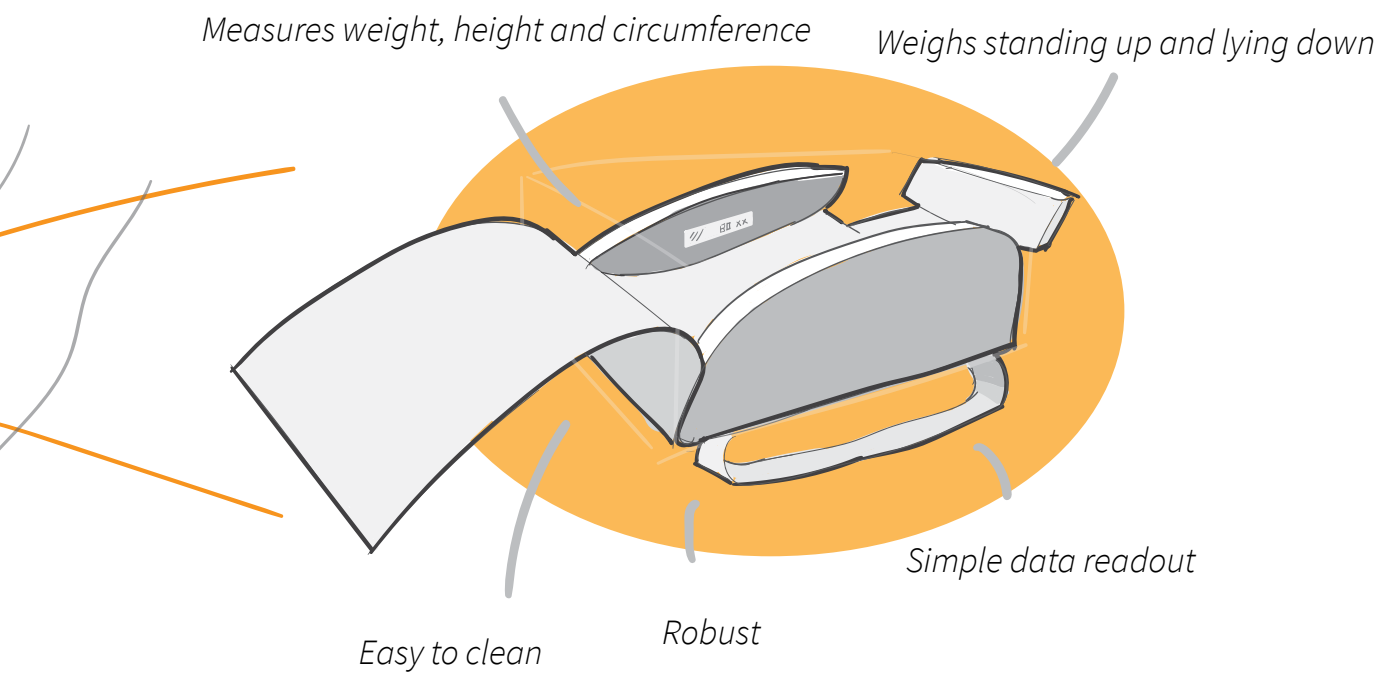
Portable

Solar powered

Measures weight, height and circumference

Weighs standing up and lying down

Simple data readout

Robust

Easy to clean

Figure 8.5: concept drawing of what the redesigned anthropometric tools in an integrated solution could look like

Chapter 9: Implementation scenarios

The last chapter ended by describing the opportunities that exist for interventions where CHVs are equipped with anthropometric measurement tools and (smart)phones, where there are various opportunities such as the impact that could be generated. In this chapter, various scenarios in which these opportunities combine are ideated and visualized. Together with experts from the KRCS, two scenarios are chosen as the most promising.

9.1 Approach

To understand how the technological enablers could be used in interventions, various scenarios were explored in which the technological enablers were used by CHV in different ways, the process is shown in figure 9.1. The scenarios differ on; the technological enablers used, the purpose of doing the measuring, and the impact that is generated. Three of the scenarios are evaluated with feedback from local experts from the KRCS, who evaluated the scenarios on their impact and feasibility. Finally, the remaining scenarios are evaluated on their feasibility, viability and desirability requirements, which are based on the insights throughout the report.

9.1.1 Chapter research questions

- What are the different possible scenarios in which the technological enablers can be used to improve on local nutritional outcomes in the first 1000 days?

9.2 Scenarios

Ideation for different scenarios in which the opportunities outlined in the previous chapter could com-

bine to form interventions was done by combining them in different ways. This is represented by the fitting of the different puzzle pieces of the scenario which represent the who, what, when and what, why, and how of the intervention, an overview of the resulting scenarios is shown in figure 9.2. Each scenario combines the opportunities in different ways. In total, seven scenarios were conceived. Three of these were chosen for further detailing and evaluation, based on their different impacts on the system and different levels of innovativeness. The three that were chosen for further detailing and evaluation are:

- Community-based growth monitoring

- Follow-ups of wasting and stunting

- Promoting family food security

A further three scenarios (early signalling of wasting and stunting, effective outreaches, and community decision making) were explored and can be found in the appendix B.1.

In these scenarios, the anthropometric measurement tools that are used are currently visualized as the existing and available tools. However, as the opportunity for redesigned anthropometric tools outlines in the previous chapter, these scenarios could work with the redesigned tools as well.
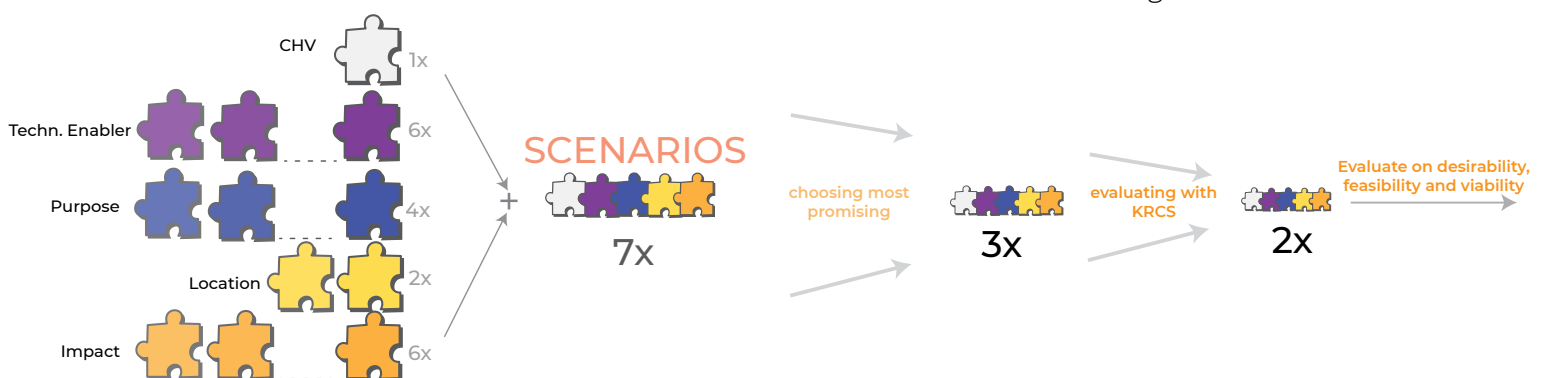

*Figure 9.1: Overview the process of the ideation, conceptualization and evaluation of the scenarios*

| Scenario	Who	Purpose	Techn. Enablers	Location	Impact
1 Community-based growth monitoring	CHV + Caregivers	Growth monitoring	Weight, length/height, MUAC, Phone documentation	Caregivers home	Awareness, Prevention
2 Early signaling	CHV + Caregivers	Early stage diagnosis stunting and wasting	Weight, height/length, MUAC, Phone documentation	Caregivers home	Improved treatment outcome
3 Remote follow-ups	CHV + Caregivers + Facility Health Workers	Follow-ups for stunting and wasting	Weight, height/length, MUAC, Phone documentation, Phone communication	Caregivers home	Improved treatment outcome, Linking facilities and communities
4 Promoting family food security	CHV + Caregivers + NGO	Early stage diagnosis of stunting and wasting	Weight, height/length, MUAC, Phone documentation, Phone communication	Public space	Food security
5 Effective outreaches	CHV + Caregivers + NGO	Surveys	Weight, height/length, MUAC, Phone documentation, Data analysis	Public space	Food security, Improved treatment outcome
6 Community-led decisions	CHV + Caregivers + Community Leaders	Surveys	Weight, height/length, MUAC, Phone documentation, Data analysis	Public space	Food security, prevention

Figure 9.2: Overview of the different implementation scenarios and the related intervention variables

① Community-based growth monitoring

Growth monitoring is currently supposed to be done regularly at facilities. However, due to accessibility concerns of facilities, shortage of staff and lack of recognition of the importance of growth monitoring, it is often not done. In this scenario, CHVs go to the families with young infants, to conduct regular growth monitoring on a community level, thus both increasing awareness of the importance of nutrition in the first years of life among community members and noticing any nutrition related development problems early.
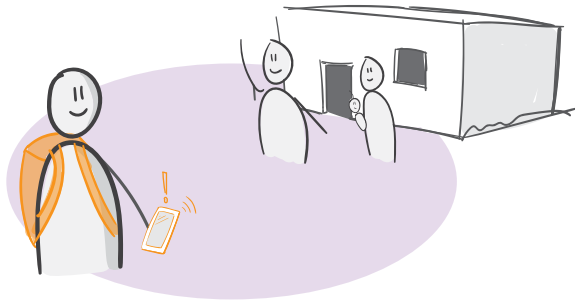
1. CHV gets notified to visit the house where a newborn is born on a monthly basis
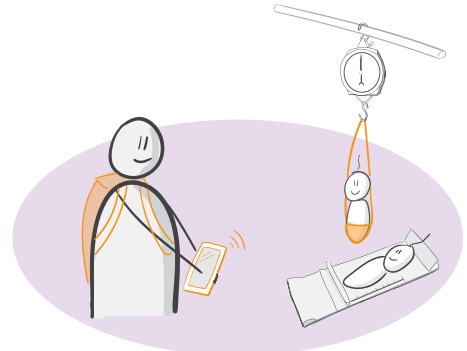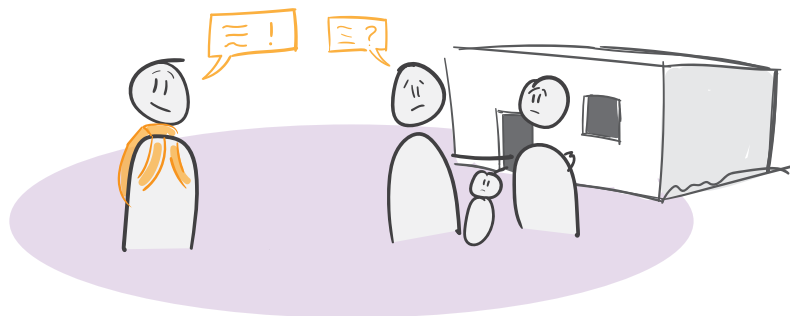
2. CHV measures length and weight of the child and documents the results on a phone
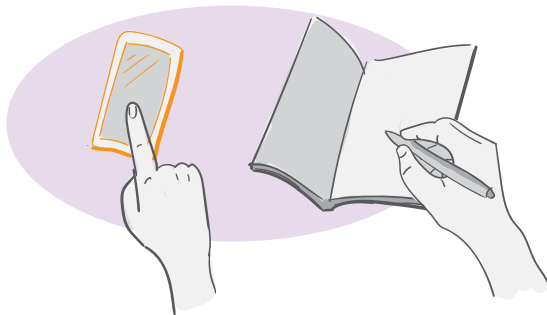
3. CHV enters the data on the phone or growth booklet of the caregivers

4. CHV and caregivers view the development results in the booklet/app

5. CHV does consultation or refers if necessary

Reason for selecting as promising

Growth monitoring on a community level was chosen as it answers one of the main opportunities for impact that was found during the fieldwork. Growth monitoring is known to be important, and by bringing the anthropometric tools to communities it could easily enable the location of growth monitoring from hospitals, which is currently ineffective, to the community level.

2 **Remote follow-ups**

Currently, after an initial diagnosis of undernutrition, many caregivers return home with treatment and are supposed to travel back and forth to facilities for follow-ups to see if their infant is improving. In this scenario, follow-ups of moderate undernutrition cases are done in communities by CHVs, thus reducing the amount of times that caregivers have to travel and improving the healthcare pathway.
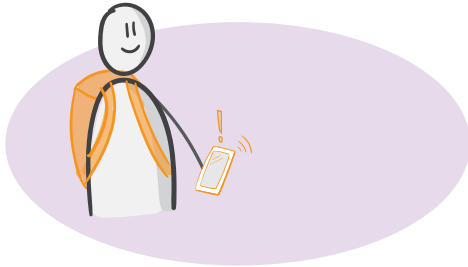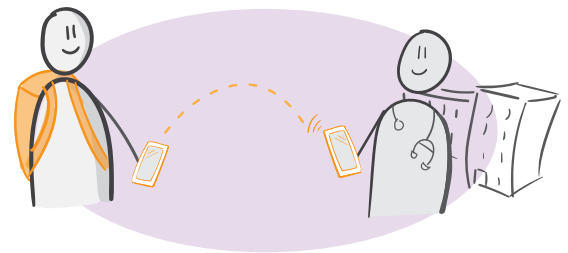
1   CHVs receive a notification from a facility health worker to do a follow-up on an infant that was seen in a facility recently for undernutrition
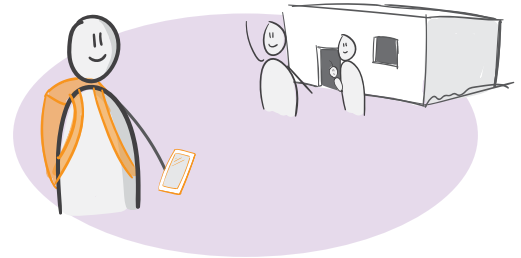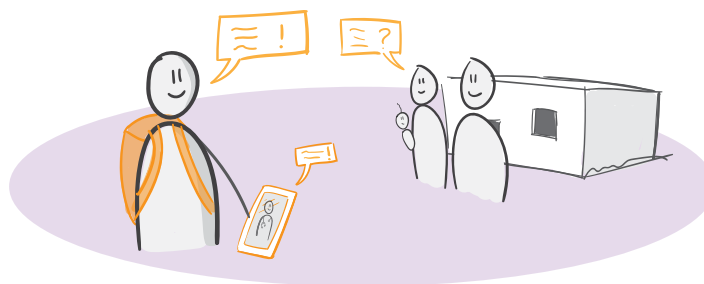
2   CHV goes and visits household
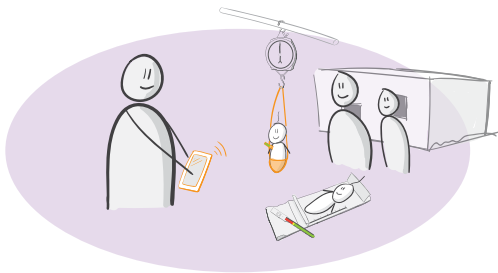
3   CHV does the relevant measurments and enters the data on their phone

4   CHV communicates results to relevant facility

5   CHV refers if necessary and does consultation, with the specialist on (video) call if needed

Reason for selecting as promising

The fieldwork showed that one of the key opportunities is that there is a missing link between communities and facilities, as facility health workers are often frustrated that they cannot follow their patients outside of the facilities. The technological enablers in this case, through the communication of results via phones, opens up new opportunities to solve an obvious local need.

3 Promoting family food security

Many families struggle to put food on the table, which is especially problematic if they have infants in the first years of life. In this scenario, families can go to the market and get their children measured by a CHV. If there are signs of undernutrition, an associated market stall from a connected NGO supplies food directly to the caregivers.
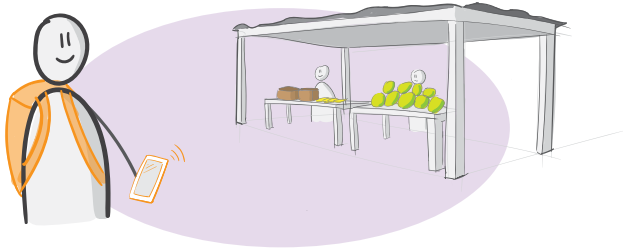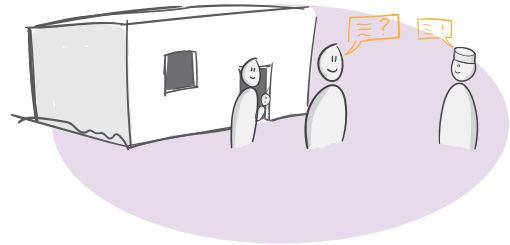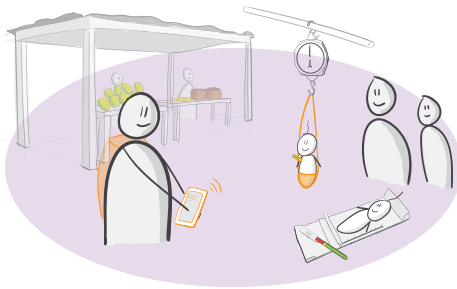

1. CHV brings the measurement tools to the local food market on a certain day of the week

2. Caregivers that have issues feeding children are informed they can go to see the CHV at the market

3. CHV measures and tracks the development of infants that caregivers bring
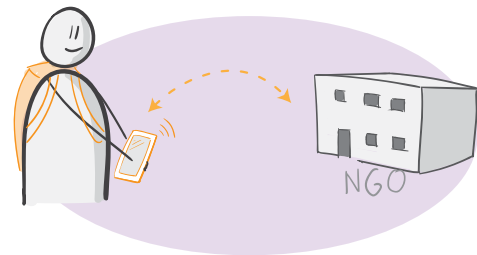
4. If there are any danger signs of undernutrition, the CHV puts it in the app, notifying the NGO. This gives the CHV a one-time code that can be used in an associated market stall for a food package
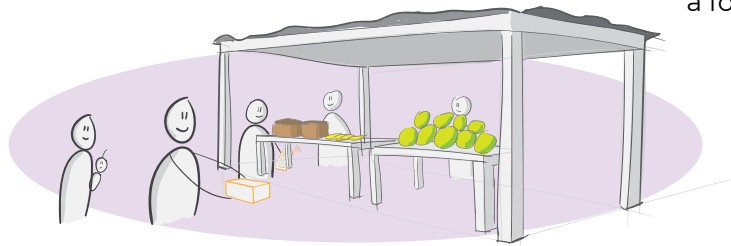
5. The CHV communicates the paid for code with the market stall, and the caregivers receive the food package directly from the stall, paid for in advance by the NGO

Reason for selecting as promising

This scenario was chosen as it is a bit "out-of-the box", and shows how innovative connections could be made with the help of the technological enablers.

9.3 Evaluation of scenarios with KRCS

The three detailed scenarios were evaluated to understand which one would be most suitable to implement in the short term. Feedback from local experts from the KRCS was central in this evaluation, and they were asked to give their initial thoughts, advantages and disadvantages of each scenario and rank them on impact that it could generate and the feasibility of the intervention. Three local experts from the KRCS replied with filled in feedback forms which detailed the scenarios and asked for their opinion, the full results can be found in appendix C.2

In the end, the community-based growth monitoring seems the most promising, with the remote follow-ups scenario a close second.

Community-based growth monitoring:

The community-based growth monitoring scenario was consistently ranked highly both for impact and feasibility. It was especially valued as it both improves acceptance and utilisation of nutritional health services on a community level as well as generating knowledge and awareness.

The main pros for the scenario were that it could lead to better acceptance and utilisation of nutritional care by community members, as the regular visits could improve trust towards nutritional health services. Furthermore, it could increase knowledge on nutrition among communication members. Also, it would lead to early detection of any nutrition related development milestones and smooth referrals if needed.

"Most community members in Lamu, especially the hard to reach areas, rarely visit health facilities

because of many factors that influence their access to such places. Through scenario 1, nutritional outcomes can be improved at the community level by the CHVs" - KRCS innovation expert

Some of the barriers that were expressed include the lack of or inadequate phones to use, the knowledge of CHVs in operating the phones, necessity of medical background for interpretation of the data. An unstable phone network should be accounted for, so that data would not be lost in case the connection drops out.

Remote follow-ups

The remote undernutrition follow-ups scenario was also found to be impactful and feasible, though there were some concerns expressed on putting CHVs in charge for handling potentially severe undernutrition cases.

The main pros for this scenario was that it would enhance the referral pathway, enable access to sustained help from healthcare workers for those who are not able to access facilities. It was also noted that this could improve the relations and coordination between health care workers in facilities and communities.

"[Remote follow-ups would cause] better relations and coordination between the health care workers in the health facilities and the community health volunteers - KRCS innovation expert

Some of the cons that were expressed for this scenario include concerns over whether cases would be handled with satisfaction, as it would shift responsibility to CHVs for potentially problematic cases without the training and medical background of a normal health worker.

Promoting family food security

The promoting family food security scenario was appreciated for its targeting of families in need. However, some concerns around unintentional consequences such as intentional neglect by families to get provisions and the cost of implementation were mentioned. It was therefore ranked lowest in both impact and feasibility.

Some of the pros that were mentioned include that it contributes to increasing awareness and participation of community members, and that it would allow for customised, targeted and efficient food interventions.

The cons for this scenario include that community members could start to rely too much on these rations, that there would be privacy concerns and concerns around the sustainability of the initiative, as it could prove costly and be difficult to implement. Furthermore, one respondent noted that, as an unintended consequence, families could start to intentionally neglect an infant to obtain the rations.

"scenario 3 [promoting family food security] is less impactful cause it can create intentional neglect so as the caregivers can get free food." - KRCS doctor

9.4 Chapter conclusions

In short, this chapter looked at how the different opportunities that were defined in the previous chapter could combine to form interventions. Six intervention scenarios were created, all different on the way the technological enablers were used, what the purpose for doing the measurements of infants was, the impact that was generated and where the measurements take place. Three scenarios that were selected to evaluate further with local experts from the KRCS. This evaluation showed that the biggest opportunity in Lamu is for the community-based growth monitoring and remote follow-ups scenarios.

9.4.1 Key takeaways for interventions

As no new research insights are present in this chapter, no requirements and wishes stem from this chapter. There are however some key takeaways:

- There is a wide range of scenarios in which basic nutritional health services by CHVs using the technological enablers could be used

- Two of the proposed scenarios are most promising; community-based growth monitoring and remote follow-ups

Housing of caregivers that were interviewed

Chapter 10: Intervention evaluation

This chapter aims to evaluate the proposed intervention scenarios on their feasibility, viability and desirability. It describes some of the barriers that implementation of the scenarios could face and how they could be overcome. It also describes next steps that could be taken and how the implementation development approach could be.

10.1 Approach

To evaluate the community-based growth monitoring scenario and the remote follow-ups scenario, which were selected in the previous chapter, we evaluate them on their feasibility, viability and desirability. The requirements for these three domains are taken from the "key takeaways for interventions", that have been described at the end of each chapter. Next, to explore potential barriers to the further design and implementation of the scenario, a session was held with an innovation expert for sub-Saharan Africa.

10.1.1 Chapter research questions

The main research question that this chapter aims to answer:

To what extent would the selected intervention scenarios improve nutritional outcomes in the first 1000 days in Lamu?

- What are the desirability, feasibility and viability for the two selected intervention scenarios?

- What are the barriers for implementation of the two selected intervention scenarios?

- How could the intervention be further developed?

10.2 Desirability, feasibility and viability

As this project was of an explorative nature, the requirements concerning desirability, feasibility and viability were not quite defined at the start of the project. Throughout the project however, we have formed an understanding of the local context so that we can now reflect on whether the intervention scenarios that were chosen could be considered desirable, feasible and viable. These requirements have been summed up at the end of each chapter. Because of the explorative nature, they are general requirements, rather than offering specifics. Here, we evaluate the two selected scenarios; community-based growth monitoring and remote follow-ups, based on their desirability, feasibility and viability.

10.2.1 Desirability

Does it address the community's values and needs?

From the evaluation in figure 10.1, the growth monitoring scenario is best suited to the values and the needs of the local communities to improve nutritional outcomes in the first 1000 days. Compared to the remote follow-ups scenario, it is better suited as it is a preventative approach.

Requirements *Desirability*	Origin	Community-based growth monitoring	Remote follow-ups
Interventions should improve nutritional health outcomes in the first 1000 days and aim to reduce inequalities between and within communities	CH6	Growth monitoring is widely employed and recommended by UNICEF to improve outcomes	Remote follow-ups should improve on treatment outcomes, but its efficacy should be further researched
Interventions should focus on prevention or early recognition of the various forms of undernutrition to be most effective	CH4	Would signal development problems at an early stage	Focuses on treatment, a later stage of healthcare journey
Interventions should accommodate caregivers, as they have busy and challenging lives	CH5	It brings growth monitoring to the caregivers' house	Reduces need for caregivers to travel back and forth to facilities
Interventions should not go against the strong local cultural, social and religious identity to increase acceptance	CH5	No indication that it goes against the discovered values and norms, but should be considered in further implementation	No indication that it goes against the discovered values and norms, but should be considered in further implementation
Interventions should build on the strong social cohesion and informal structures that exist	CH5	Builds on network of CHVs	Builds on network of CHVs
Interventions should be designed and implemented together with relevant stakeholders, such as community leaders, to increase the chance of acceptability	CH5	Communities should be involved during future implementation	Communities should be involved during future implementation
Opportunities/wishes *Desirability*	Origin	Community-based growth monitoring	Remote follow-ups
Interventions could provide economic opportunities to locals, as they are sought after in the region	CH5	If CHVs are financially compensated for their efforts	If CHVs are financially compensated for their efforts
Interventions could enable part of the health services to be taking place in communities, such as for initial initial nutritional diagnostics, nutritional follow-ups from facilities or growth monitoring	CH6	Brings nutritional health service to community level	Brings nutritional health service to community level
Interventions could address food insecurity concerns	CH6	Does not address food insecurity	Does not address food insecurity
Interventions could promote awareness and information on healthy nutrition practices within communities	CH6	Growth monitoring is known to increase awareness	Not directly contributes to increasing awareness
Interventions could focus on using technology to bridge barriers to accessing healthcare	CH7	Uses technology to overcome barriers	Uses technology to overcome barriers
Interventions could focus on providing information on healthy practices or on sending reminders	CH7	Does not focus on providing information on healthy practices or on sending reminders	Does not focus on providing information on healthy practices or on sending reminders
Interventions could focus on gathering inclusive and accurate community nutritional data, as this is currently not available which can contribute to inequalities.	CH	Data is collected, but not aggregated and shared, which could be explored.	-

Figure 10.1: Evaluation of the two implementation scenarios on the desirability requirements

10.2.2 Feasibility

Can it be done?

As far as feasibility is concerned, both scenarios use affordable and available technologies, which is the main requirement. The evaluation for the feasibility requirements is shown in figure 10.2. For both scenarios, the way that they handle data should be researched in the detailing of the interventions, as it should comply with the relevant regulations.

10.2.3 Viability

Will it survive on a longer term?

Both scenarios comply with the main requirements, as can be seen in figure 10.3. The main requirement where both need to focus on is in the compensation of CHVs. In general, the requirements presented here are not specific, and further steps should be taken to look in detail into what requirements exist to ensure viability and affordability of the proposed interventions. This is further explored later in this chapter under "further development".

10.2.4 Evaluation conclusions

From the two chosen scenarios by KRCS, the community-based growth monitoring scenario complies with the most requirements. This is in line with the KRCS evaluation, as they had the same slight preference. Both scenarios need more detailing and research, especially when it comes to the feasibility and viability.

Requirements *Feasibility*	Origin	Community-based growth monitoring	Remote follow-ups
Intervention should make use of available and affordable technologies	CH3	Makes use of simple and available anthropometric measurement tools and widely available (smart) phones	Makes use of simple and available anthropometric measurement tools and widely available (smart) phones
Interventions that gather nutritional data should comply with national regulations	CH7	Needs to be researched in the detailing of the intervention	Needs to be researched in the detailing of the intervention

Opportunities/wishes *Feasibility*	Origin	Community-based growth monitoring	Remote follow-ups
Interventions could make use of anthropometric measurements for diagnosis and prevention of undernutrition, as they are available, affordable and not overly complex	CH4	Makes use of anthropometric measurement tools	Makes use of anthropometric measurement tools
Interventions could make use of simple communication technologies such as sending messages via SMS/calling	CH7	Does not use communication in the form of SMS or calling	Uses calling to connect facility health worker with caregiver
Interventions could focus on making anthropometric measurement tools available on a community level, as they are currently only available within facilities	CH7	Makes anthropometric measurements tools available on a community level by providing them to CHVs	Makes anthropometric measurements tools available on a community level by providing them to CHVs
Interventions could make use of (smart) phones, as they are widely adopted in Lamu	CH7	Makes use of (smart)phones	Makes use of (smart) phones

Figure 10.2: Evaluation of the two implementation scenarios on the feasility requirements

Requirements *Viability*	Origin	Community-based growth monitoring	Remote follow-ups
Interventions should be framed from a positive perspective, such as framing the health challenge in the form of "healthy nutrition", as this generates acceptability from stakeholders.	CH3	Growth monitoring is framed from a positive perspective	Follow-ups is not framed from a positive perspective, it only comes into play in case of undernutrition
Interventions should focus on the community level, as it is in line with the recommendations of the WHO to improve nutritional outcomes of young children and aligns with the national strategy.	CH6	Focuses on the community level	Focuses on the community level
Interventions that work with CHVs should compensate them for their efforts	CH6	Compensation for CHVs has not been addressed in this project, recommendations are given in this chapter	Compensation for CHVs has not been addressed in this project, recommendations are given in this chapter
Interventions should make use of low-cost technologies and be affordable in implementation	CH7	Makes use of low-cost technologies. Cost of implementation depends on complexity in the detailing of the intervention and should be researched	Makes use of low-cost technologies. Cost of implementation depends on complexity in the detailing of the intervention and should be researched

Opportunities/wishes *Viability*	Origin	Community-based growth monitoring	Remote follow-ups
Interventions could leverage on the system of Community Health Volunteers (CHVs) to promote nutritional health outcomes on a community level	CH6	Leverages on the system of CHVs	Leverages on the system of CHVs

Figure 10.3: Evaluation of the two implementation scenarios on the viability requirements

10.3 Barriers

10.3.1 Input from sub-Saharan African innovation expert

The potential barriers, drivers and specifics of implementation of the scenarios was discussed in a session with Ana Santos (an expert with extensive experience of working in the who worked for a long time at Médecins Sans Frontières). The discussion helped to understand aspects such as barriers for implementation and discussing options for financing of CHVs as described below.

10.3.2 Compensation of CHVs

Currently, CHVs work on a volunteer basis, i.e. they do not get a financial remuneration for their efforts. They are motivated by getting training and education and taking care of their community. Something that was mentioned in many interviews whenever discussing the role of the CHV in Lamu, was that providing adequate compensation and motivation to CHVs is a critical aspect of any intervention that aims to build on the system of CHVs.

This is a barrier that has so far not been addressed in this project, but there are opportunities for overcoming this. There are two ways of approaching the compensation: financial and non-financial. These

There are three options for financial compensation: Out-of-pocket (OOP) payment, structural incentives from the government, and direct payment for work done through donations. Out-of-pocket (OOP) payments, where caregivers directly pay CHVs for services, are not a suitable option. Many caregivers and communities in need of healthcare services do not have the finances available to pay for these services. This can lead to inequality in accessing healthcare services, as those who cannot afford to pay may be excluded from the intervention. Therefore, relying on OOP payments would be unfair and contradict the goal of the intervention to reduce inequalities in health.

Relying on governments to provide structural incentives for CHVs would be ideal, as it would create a more sustainable and equitable system for compensating CHVs. However, in many cases, this has not been done. It is hard to structurally change it on a policy level, especially in developing countries with limited resources.

Another option is to find ways to pay CHVs for the work they do in the intervention directly from donations from people in wealthier countries that want to do good. This approach has the potential to overcome the limitations of OOP payments and government funding by creating a new, independent source of funding that is not tied to existing

"The CHV's could play a bigger role [than they currently do], but only with the right motivation. If they lack the motivation, through the stipends, we have to pull and push them." - Facility nutritionist

"But if the CHVs are not compensated there is no point. It would be unfair to start a new product using them and not renumerate them. There is a structural problem. The remuneration of CHV is usually based on projects. The NGO comes in and pays them and they leave. It is not structural. You could also think about something different then money, give them access to networks and training to find a better job, which is what they want. Instead of thinking about payment, think about different values." - Innovation expert sub-Saharan Africa

healthcare systems or policies.

Non-financial strategies for motivating CHVs could also be implemented, by providing them with something they value outside of money. For example, providing CHVs with other things such as a professional network or various trainings which could lead to them finding a "better" job. These strategies would help to improve the status and recognition of CHVs.

How CHVs could be compensated needs to be further explored for the intervention design.

10.3.3 Data collection and regulations

Any intervention that wants to collect data should comply with the local regulations. Based on the conversation with Ana Santos, a popular data collection platform that is used by many NGOs for these types of interventions is Comcare, an open-source mobile data collection and service delivery platform (World Health Organization, n.d.-a). This should be looked into for the further development of the integration of the data documentation on phones.

10.4 Further development and implementation

This project concluded the intervention design by exploring and understanding where interventions could be targeted to improve the nutritional status in the first years after birth in Lamu. Two scenarios are especially promising for interventions, community-based growth monitoring and remote follow-ups, of which the growth monitoring is seen as the most promising by experts from the KRCS and from the evaluation.

To further the intervention design, next steps should focus on prototyping and detailing the way that the technological enablers are used together and how the data is stored and communicated. They should be prototyped with stakeholders in the field.

The following questions should be answered as a next step:

Desirability:

- Does the intervention go against any local cultural norms or values that are currently not known?

Feasibility

- With what rules and regulations should the data that is gathered comply?

- Which data collection system should be used?

- Can feature phones be used or should smartphones be used?

- Should phones of CHVs be used or should we supply them with smartphones?

- How should the user experience with the phone interaction be for the documentation of data and communication of results for the various stakeholders?

- Can the anthropometric measurement tools be integrated into a single device, as is proposed?

Viability:

- How could the intervention implementation be financed?

- Who could and should implement the intervention, and how could the intervention match the organisational strategy of that stakeholder?

- How can CHVs be compensated for their efforts?

10.4.1 Design and implementation strategy; starting small and scaling up

Based on the research into other initiatives and interventions in the sub-Saharan context, it would be best to start implementation of the chosen scenarios on a small scale, with a variety of communities and involving those communities in the process is recommended. This approach would allow for adjusting and iterating on the design based on the insights gained from the first communities, could create trust from the communities and keep initial costs low.

Choosing different communities for testing the intervention would help in gaining a representative understanding of the county. For instance, one community could be selected that is more urban and closer to a health facility, and another community that is more remote. This approach will help in determining the effectiveness of the intervention in different settings, and provide valuable insights that can be used to refine the intervention design.

Testing the intervention on a small scale is also a practical way to identify any potential challenges or barriers to implementation. This would allow to make necessary adjustments before scaling up the intervention to a larger population.

Furthermore, the communities should be involved in the process. This can be done by engaging community members and leaders in the planning and implementation of the intervention. This approach will help build trust and ownership of the intervention among community members, and also provide a platform for feedback and suggestions on how to improve the intervention.

Also, it is important to establish a monitoring and evaluation plan to track the progress and impact of the intervention in the selected communities. This will help in determining the effectiveness of the intervention and also provide valuable data that can be used to make informed decisions on how to scale up the intervention to other communities.

10.5 Chapter conclusions

This chapter evaluated the selected scenarios on their feasibility, viability and desirability. The result was that the community-based growth monitoring scenario is best suited, mainly as it is a more preventative approach compared to the remote follow-ups scenario. This result is in line with the evaluation from the KRCS experts of the previous chapter. Furthermore, some of the barriers that these intervention scenarios could face were explored with a sub-Saharan African innovation expert. The main one, the compensation of CHVs, is described and suggestions are given on how it could be overcome. Finally, a strategy for further design and implementation is described, which focuses on starting small, working closely with communities, adjusting where necessary and finally, scaling up.

9.4.1 Key takeaways for interventions

As no new research insights are present in this chapter, no requirements and wishes stem from this chapter. There are however some key takeaways:

- The community-based growth monitoring is the most promising when evaluated along the feasibility, viability and desirability requirements and opportunities that have been gathered throughout this report

- There are some barriers for implementation, the main one being compensation of CHVs

Donkeys walking on an inland road

SECTION 5

// Concluding the project //

Chapter 11: conclusions, discussion and recommendations

This final section looks back on the design process. It first discusses if the research questions have been answered, discusses the limitations and recommendations for the project and finally, reflects on the project as a whole.

Chapter 11: conclusions, discussion and recommendations

This chapter concludes the project. It first checks whether the main research questions have been answered. Next, it discusses the limitations and recommendations for the project. Finally, a personal reflection looks back on the project.

11.1 Conclusions

Have the main research questions been answered?

Section 2: scoping and finding a focus

Literature research and a strategic session with experts from the KRCS were used to determine a focus for the project. The project started with a broad goal of addressing health inequality in children during their first 1000 days of life. However, due to the need to identify opportunities for interventions, the project focuses on a specific health challenge. The criteria for selecting this health challenge include relevance in Lamu during the first 1000 days of life, cultural relevance, and opportunities for technology to make a difference. The process involved creating a map of all health risks and problems in the first 1000 days, narrowing it down based on feasibility and scope, selecting a shortlist of feasible health challenges, mapping technological opportunities for each challenge, and finally determining the focus of the project through a strategic session with KRCS. This was used to answer the research question: ***RQ1: Which health challenge is a local burden in the first 1000 days, is culturally relevant and offers opportunities for available technologies?***

Several health challenges would have been relevant for this project to focus on. Looking at the problem space, i.e., which health challenges were a local burden in the first 1000 days, the following health challenges were relevant: pneumonia, stunted growth, HIV, neonatal disorders , dengue fever diarrhoea/cholera and asthma. After researching and estimating the solution space for each challenge, i.e. is it not overly complex and does it offer opportunities for available technologies, two health challenges stood out were relevant and offered opportunities: stunted growth and pneumonia. Experts from the KRCS agreed that it would be best to focus on stunted growth, but to reframe it to (un)healthy nutrition, as it was something that had not been focused on much in the region, was relevant in the culture and, in their view, could make a significant impact.

Section 3: understanding Lamu context

A combination of methods were used to form an understanding of the context of (un)healthy nutrition and Lamu. First, a WWWWWH approach to (un)healthy nutrition was used to gain a comprehensive understanding of (un)healthy nutrition and the local healthcare system, primarily through literature research. To understand the makeup of the local society, local context of nutrition, and needs around local healthcare, a combination of literature research, fieldwork interviews, and observations was used, with the fieldwork especially providing crucial qualitative insights into the local context. Next, literature research, fieldwork interviews and observations were used to explore how technologies are generally used to facilitate innovation in the sub-Saharan context, which tools and technologies could be used in the context of (un)healthy nutrition, and how technologies in general are currently used in Lamu. This was used to answer the second and third main research questions: *RQ2: What are the problems, needs and opportunities in the local current context around (un)healthy nutrition in Lamu communities in the first 1000 days?* and *RQ3: Which available technologies are used in the context of (un)healthy nutrition and in Lamu communities?*

The section provides the main insights that lead to the opportunities that are used for the following intervention design section. Unhealthy nutrition comes with three broad forms - wasting, stunting, and micronutrient deficiencies, and relatively simple anthropometric measurement tools are essential in the diagnosis of two of wasting and stunting. Growth monitoring is an effective preventative strategy for undernutrition in young children. Healthcare in Kenya consists of a public and private healthcare system with iCCM being adopted as an approach to provide basic healthcare services through a system of Community Health Volunteers (CHVs). Interventions should focus on early diagnosis and prevention of undernutrition cases. Simple diagnostic tools present opportunities, and are especially suited for diagnosing wasting and stunting.

Lamu is a diverse region with strong communities, informal networks and social cohesion. Lives of caregivers are busy and economically insecure. There are opportunities for interventions to leverage on the informal networks and social cohesion, and interventions should keep in mind the strong local cultural norms and values.

People in Lamu were found to struggle with food insecurity, either due to low availability or because people could not afford it. There is a lack of awareness among community members of the importance of a varied and sufficient diet, and cultural superstitions can negatively affect dietary intake. Because the onset of symptoms with undernutrition is slow and gradual, caregivers often postpone seeking help from facilities. Caregivers face challenges in seeking healthcare due to accessibility, availability, and affordability concerns especially. Among these, the main issue is travelling to facilities, which can be both time consuming, uncomfortable and expensive. Regular touchpoints with healthcare facilities in the first 1000 days exist, but people are known to miss appointments and growth monitoring especially is less prioritised. Of the three forms of undernutrition, wasting is often treated, micronutrient deficiencies can be limited in diagnosis and supplements, and not much is currently done about stunting. The resulting inequalities lead to suboptimal nutritional health outcomes, particularly for communities that are more remote. There are opportunities to bring basic nutritional health services from facilities to communities, which could reduce accessibility concerns, improve on food security and increase awareness on the importance of healthy nutrition among community members.

In Lamu, there is widespread adoption of (smart) phones and social media, which all represent opportunities for technology to be adapted to meet the needs of local communities.Diagnostic tools for measuring undernutrition are currently solely found in facilities, with MUAC-tape being currently rolled out among CHVs. There are opportunities for these diagnostic tools to enable nutritional based health services on a community level, especially when combined with phones.

Section 4: Intervention design

The insights from the context and technology research of section 3 were used in this section to describe the opportunities that are there for technology-driven interventions. These opportunities were combined in different scenarios. Some of the basic elements of these scenarios were evaluated and co-created in a session with two CHVs during the fieldwork. Three of the scenarios were evaluated with local experts from the KRCS, which resulted in two scenarios being selected as the most promising; the community-based growth monitoring scenario and the remote follow-ups scenario. Next, these two remaining scenarios were evaluated based on their feasibility, viability, and desirability, using the key takeaways from previous chapters throughout the report. Additionally, a session with an innovation expert for sub-Saharan Africa gave insight on potential barriers to the design and implementation of the scenarios. This was used to answer the fourth main research question: ***RQ4: How could a product-service-system (intervention) improve the healthy start to life in Lamu using available technologies within the local current context (phase 4)?***

There are available technologies for improving nutritional health outcomes in the first 1000 days of life in Lamu in the form of anthropometric measurement tools and (smart)phones. CHVs are in the best position to do measurements on infants in their communities. Six intervention scenarios were created that varied on the way the available technologies are used, the impact that is generated, the location and purpose of doing the measurements. Three scenarios were selected for evaluation with local experts from KRCS. The community-based growth monitoring and remote follow-ups scenario were selected by them as most impactful and feasible. A further evaluation on the desirability, feasibility and viability of these two scenarios resulted in that the community-based growth monitoring scenario was found to be the most promising scenario. The main barrier that these interventions face are in the compensation of CHVs, and ways are suggested to overcome them. Finally, a strategy for further design and implementation was described, which involves starting small, working closely with communities, adjusting where necessary, and scaling up.

Lo-fi prototype that was used to evaluate and co-create the basics of the proposed interventions with CHV

11.2 Discussion

Limitations and recommendations

11.2.1 Limitations

Fieldwork limitation:

Limited locations

Most of the local stakeholders that were interviewed, facilities that were visited and communities that were interacted with were on the main island, Lamu island. One health facility and NGO that were visited were on the mainland, and one facility was visited on another island, Faza. As such, the more remote and underserved communities and facilities were not interacted with. Interviews with stakeholders about these underserved communities gave insight on these communities and facilities, but these insights are probably indicative at best and not representative. The insights from the context and technology research can therefore be limited in how much it can be generalised across different communities and facilities in Lamu.

Language barriers

Most people that were interacted with in Lamu spoke English, except for some caregivers that were visited. English was often not the primary language however, and the manner of speaking English is different than in the Netherlands. This might have resulted in superficial expression of views and there might have been some errors in interpretation of the interview data.

Superficial insights

During the fieldwork, it was noticeable that some local stakeholders were sceptical of the research intentions and therefore at times hesitant to engage in deep discussions of the local problems, needs and opportunities. The stakeholders in Lamu were often obviously proud of their region and at times protective of their communities, and rightfully so. This might also have contributed however to some insights being superficial. This means that the insights are generally not on people's thoughts and emotions, but on a more factual basis, which might have limited how innovative the interventions that are proposed are.

Pragmatic technology focus

This project was of a pragmatic nature, where contextual research was combined with a strong focus on which technologies could be used to enable innovation. This available technology-driven focus, while providing direction and ensuring feasibility of the intervention, might however also have resulted in design opportunities that have not been explored. For the intervention concepting, all concepts make use of the anthropometric measurement tools in combination with (smart)phones. However, if this combination would have been let go of, there might have been innovation possible using just smartphones,, or maybe without using technology at all. These innovation directions have not been explored.

Remote scenario concepting and evaluation

The fieldwork lasted for four and a half weeks and took place about halfway through the project. Due to the timing, it mostly informed the understanding of Lamu as described in section three. The concepting of interventions was done remotely, in the Netherlands. This, combined with the fact that remote and digital communication with the local stakeholders was challenging, means that the concepting stage of the project was done on the insights that were gathered during the fieldwork, but there was no continual evaluation and testing possible of the concept directions. Evaluation was done in the form of feedback forms.

11.2.2 Recommendations:

Detail, develop and implement of scenarios with local stakeholders

Many interventions in contexts such as Lamu have the same fate. They are set up by an NGO or other organisation, work for a while and then the program closes as financing stops and there is no lasting change. To avoid this, further development of the intervention should be done together with local stakeholders as much as possible. This could be together with an organisation like the KRCS, which has a permanent presence in the region, or together with the public health authorities. In this way, local stakeholders can have an ownership over the project, which would make any impact that the intervention could make more sustainable. Furthermore, by developing the intervention in close collaboration with local communities, adjustments can be made where needed, as there is still much that is unknown about the local context after the fieldwork done for this project.

Explore integrated measurement device

In chapter 8.xx, an opportunity was described to combine the various anthropometric measurement tools into a single, integrated device, that could

exist on a community level. This was mostly based on the interviews with stakeholders, which revealed that many anthropometric measurement tools are not ideal to be used on a community level. The opportunity to redesign these tools should be further explored and evaluated.

11.3 Personal reflection

For my graduation project I wanted to tackle a complex societal challenge by designing concepts that could open up new directions for innovation. This project fit that description, as it was of an explorative nature that needed to understand a complex system before trying to come up with new interventions that could make a meaningful change. The fact that the context of this project was in Lamu further motivated me to do the project, as it would push me outside of my comfort zone and required that I changed my approach to the design process to be more collaborative and co-creative, which was something that I was interested in developing. You also do not often get the chance to design for such a foreign context, and I felt that there would be much to learn.

The main challenge that this project presented was that I was an outsider to the context who attempted to design something that could improve it. This gave me an uncomfortable feeling at first, as there is a risk present here of imposing your own cultural standards, norms and ideals on another context that you are not going to fully comprehend. Dealing with this sense of discomfort, I tried as much as possible to see myself as a facilitator of the design process rather than being the designer. By this I mean that I tried to make every step of the design journey as collaborative with experts from the local contexts as much as possible. For example, when finding a focus for the project, my research resulted in serving up a couple of suggestions on which health challenge could be focused, and the final decision was made and reframed together with experts from the KRCS. It also changed the way I approached the fieldwork interviews, viewing everyone I encountered as an expert of the local context that I could learn from, and exploring possible intervention directions in interviews and co-creatively with CHVs. In the end, in part due to the fieldwork only lasting for a month, not every part of the process was as collaborative as I had hoped, as it would have benefitted the project to do more prototyping and evaluating of different concept directions while in the local context. But you can only do as much as you can.

At the start of the project I formulated several personal learning goals. The first was to improve on using visualization techniques throughout the design process, such as drawing and using photography. Looking back I can confidently say that I feel that I have made progress in this. Especially in using drawing to communicate ideas and concepts I have improved, and I hope that the photos throughout this report have helped in communicating the context and the design process. Secondly, I wanted to get better at managing complex multi-stakeholder projects and promoting the project. I feel I have managed to connect the project quite well to the healthy start initiative, and hopefully the project serves as some inspiration. Managing the local stakeholders was a challenge, I hope that I have been able to connect with them appropriately and that I have given something back that they appreciate.

Some of the team members of KRCS, the makerspace and their students, and me in front of the local makerspace

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