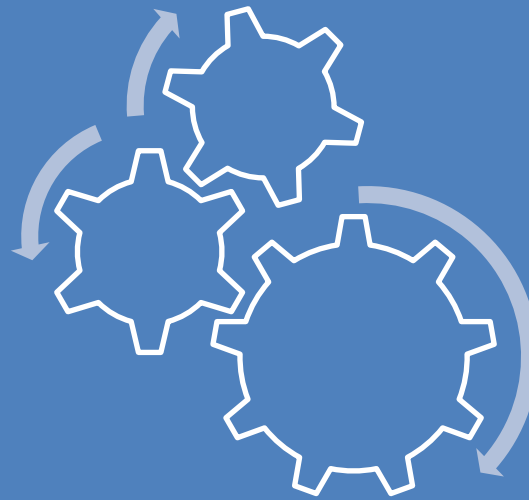


Circular Business Models

By Maurice van den Oever



Research report

Circular business model for a screening
and triage device in Kenya

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Foreword

This report is the result of five months of research, in the context of my graduation project for the bachelor 'Climate and Management' at the Hague University. From February 2015 till June 2015, I have been engaged in the research and writing of this research report.

This report was written on the behalf of the company, Philips Design. Together with my supervisor, Geert Christiaansen, I developed the research questions for this report. The research I did was a challenge, but after extensive work and the great support of my coaches I succeeded in answering the questions.

Hereby I would like to thank my supervisors for the guidance and support during this process. I also want to thank all the respondents within Philips. Without the cooperation of the respondents I would not have been able to carry out this research.

I would also like to thank the other colleagues at Philips for their intensive cooperation and support, in particular Jeroen van Kuringen en Rick Bezemer. I could often brainstorm with all of you about the research, which was really helpful.

I hope you enjoy reading.

Maurice van den Oever

Eindhoven, June 8, 2015.

Research report (thesis)

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Company Profile

Royal Philips of the Netherlands is a diversified technology company, focused on improving people's lives through meaningful innovation in the areas of Healthcare, Consumer Lifestyle and Lighting. The company is a leader in cardiac care, acute care and home healthcare, energy-efficient lighting solutions and new lighting applications, as well as male shaving and grooming and oral healthcare. (Philips, 2015).

Geert Christiaansen

1st company coach

Senior Director Design Innovation

Executive summary

Philips strives to make the world healthier and more sustainable through innovation, in both advanced and emerging markets. There are major differences between these worlds, also in healthcare. This is mainly the result of the limited resources in the emerging countries and the lack of availability of highly qualified doctors, which makes it impossible to monitor all the patients for possible diseases (such as pneumonia). For this reason Philips is exploring how to improve this situation by catering for less trained staff with new propositions which will offer decision support. When innovating Philips brings together different disciplines in a sustainable way. This was also the reason for Philips to collaborate in this research assignment. Various departments within Philips were affiliated with the research, notably Philips Design, Philips Research and the Sustainability department (especially for the section circular economy). Philips wants to provide a sustainable solution for the screening and triage of patients by means of the development of a new product.

Given the limited resources in emerging markets and the goal to reduce the number of environmental impacts, it is important that the developed smart health measurement device has a long lifetime, and the life cycle of the product is closed (adhering to circular economy principles). This asks for a circular business model. The current business models are based on the traditional linear consumption pattern. The future of the linear consumption pattern is insecure, because of the rising demand of resources and the increasingly affluent population. Next to this the shift to a more sustainable society is a reason for doing business in a more circular way. A circular business model focusses not only on selling products, but on the whole service around the devices. During the whole lifecycle of the smart devices the manufacturer or provider will be involved and provides service for the good use and maintenance of the products. This system-based approach is an important part in the circular

business model for screening and triage devices. The circular economy can be described as a model which replaces the 'end-of-life' concept with restoration. It promotes the use of renewable energy, eliminates the use of toxic chemicals (which impair reuse) and aims for the elimination of waste through the superior design of materials, products and systems. There are many building blocks for the development of a circular business model, in particular for the smart screening and triage devices. This report explores Bakker's five concepts, each useful for the development of a circular business model: the classic business concept (durability devices), the hybrid concept (indispensable service), the gap exploiter concept (local dealers), the access concept (new way of ownership) and the performance concept (pay-for-performance). In addition, this report explores the value creation sources and end-of-life circular stages of The Ellen MacArthur Foundation. There are four sources of value creation which are part of the building blocks: the power of the inner circle, the power of circling longer, the power of cascaded use and the power of pure cycles. These four together are a solid base for a circular business model and for this reason are part of the research.

Finally, the aspects of The Ellen MacArthur Foundation butterfly focus on all the circular stages (broken, upgrade or end-of-life) of the smart devices. These stages include many aspects, for example: maintenance, reuse/redistribute, refurbish/remanufacture and recycling of the technical materials. These aspects make it possible for Philips to develop a circular and long-term business model. In the longer run Philips wants to expand their business in Africa, starting in a few key countries like Kenya. For this reason it is important to develop a long-term relationship with all the stakeholders and provide a circular business. All these building blocks for the development of a circular business model are described more in detail in this report and are concluded in the final circular business model for the smart health measurement devices.

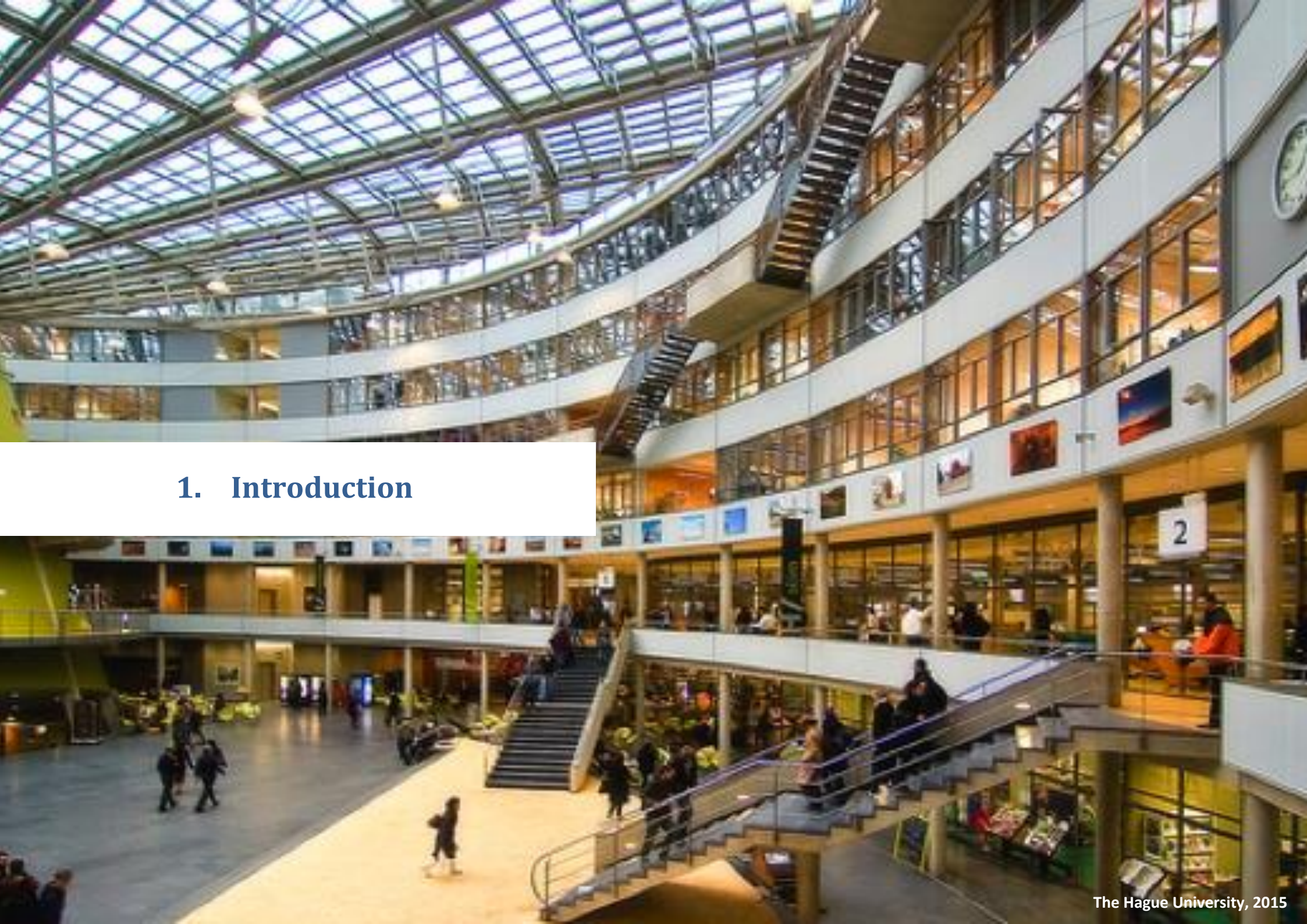
The research led to many new insights which can contribute to the development of a circular business model for the smart health measurement devices. The research shows the importance of improving the local opportunities for repairing and recycling of the devices. Furthermore, the good installment and use of the devices are important aspects, this asks for more education and training provided by Philips. But even the reduction of the theft of the devices is included in this research, because this has an impact on the circular business model. Finally, the future need for more data collection is included in the final business model.

This research shows Philips needs to develop smart devices with customer-focused aftersales services. It is important for Philips to focus more on the services around the devices, instead of only focusing on developing and selling of good quality products (traditional linear consumption pattern). The research shows that Philips needs to evaluate all the stages of the smart devices and improve the opportunities for extending the lifespan of the devices in each stage for the development of a circular business model. The insights from the research conducted in this project led to formulation of short- and long-term recommendations. These recommendations include the customer-focused aftersales services, development of a mobile/online repair assistant and the training of local biomedical engineers. All these insights are described more in detail in this report.

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1. Introduction

Philips is aiming to address some of the most pervasive health problems in Africa like hypertension and pneumonia. Smart screening and triage devices are possible solutions to unobtrusively diagnose such illnesses at primary care level. For these devices to be viable solutions in near future, it is crucial to research what the opportunities are for the development of a circular business model for the current concepts of these devices. The health facilities will use such devices on patients to make a quick, reliable and unobtrusive diagnosis. The conceptual protocol is to place the device against the patient's chest with optimal skin contact, after which it collects and analyzes the data for the health facility. With this analysis the health facility can start the process of treatment. The ambition of Philips is to distribute such devices on large scale in primary care facilities across Africa and detect illnesses in early stages, so that they can be treated in time.

According to the Economist, Western multinationals expect to find 70% of their future growth in emerging markets (Harvard Business Review, 2011). Therefore it is interesting for Philips to focus on these emerging markets. But the shortage of the right resources, the many environmental challenges (climate change, e-waste and the high demand for resources), and the sustainable and innovative ambition of Philips make it necessary for Philips to develop a more sustainable business model for these emerging markets, and thus a circular business model for the smart health measurement devices.

The current business models are based on the traditional linear consumption pattern. The future of the linear consumption pattern is insecure, because of the rising demand of resources and the increasingly affluent population. Next to this, the shift to a more sustainable society is a reason for doing business in a more circular way. A circular business model focusses not only on selling products, but on the whole service around the devices. This system-based approach is an important aspect in the circular business model for the screening and triage devices.

The circular economy can be described as a model which replaces the 'end-of-life' concept with restoration. It promotes the use of renewable energy, eliminates the use of toxic chemicals (which impair reuse) and aims for the elimination of waste through the superior design of materials, products and systems

This report is the result of extensive research during a five month period. Multiple questions are answered in this report, which will be described in the next chapters. The report starts with a clear overview of the research, where after the healthcare market in Africa (Kenya in specific) will be described. In the chapter 'Circular business model' the alternative for the current linear business models is explained. This is a business model which focusses not only on selling the products, but on the whole package of services around the products. To develop these circular business models new kind of aspects are needed. In this report these aspects are described in the chapter 'The building blocks'. These aspects or building blocks contain all the elements for the development of a circular business model. With these circular aspects or building blocks it is possible to develop different kinds of business models. In this report five conceptual circular business models are described. Each conceptual business model has its own specific circular aspects. During a workshop in Eindhoven these concepts models have been evaluated and the results of this workshop led to many hypotheses.

During a field research in Kenya these hypothesis have been evaluated, which led to many new insights. The results of the field research are concluded in the chapter 'Field research'. With the results of the field research the final business model was developed (chapter 8 'Final business model'). Finally, the results of the previous chapters lead to a clear conclusion with short- and long term recommendations. The sources which are used during the research are summarized in the literature list and the annex. The annex A contains the questionnaire which was used during the field research in Kenya.



2. Overview of the research

The research focusses on many aspect, the healthcare market in Kenya, the smart screening and triage devices and the circular economy. In this chapter is the research, the role of the aspects and the structure of the report explained.

2.1 Problem definition

Nowadays, our society faces many social and environmental challenges. These challenges are particularly present in emerging countries due to the shortage of resources and knowledge. Philips wants to reduce those challenges by developing their business models in a circular manner. Therefore Philips wants to focus on the development of a circular business model from the beginning of a project.

This research focusses on what kind of aspects can contribute to develop a circular business model, specifically for a screening and triage device for the healthcare market in Kenya. The research question and the underlying sub questions focus on the problem definition.

Research question

How can the business model for a smart screening and triage device be realized in a circular manner?

Sub questions

1. What kind of need is there for circular business models in the emerging countries?
2. What kind of aspects can contribute to the realization of the circular business model?
3. How can the different aspects be optimally combined for the development of the circular business model?

‘How can the business model for a smart screening and triage device be realized in a circular manner?’



2.2 Scope of research

There are some research boundaries formulated, in order to prevent that the research is not clear and too broad. The research will focus on the most appropriate market for a screening and triage device, Kenya. Furthermore, the research will focus on the development of a circular business model. The business model will be viewed from the Business Model Canvas (Osterwalder, 2014).

2.2.1 Screening and triage device

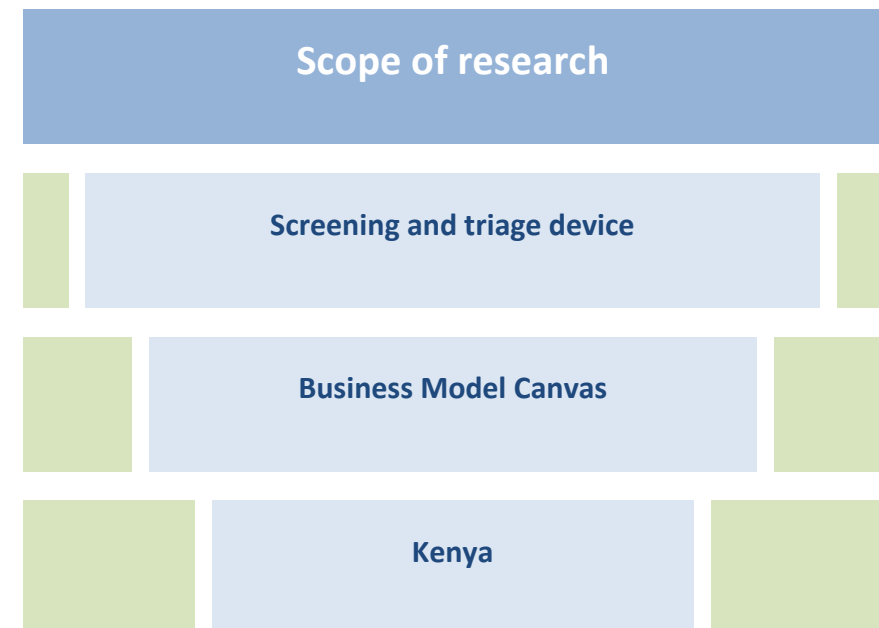
A standard health measurement device is an instrument that makes it possible for doctors and nurses to listen to body sounds and measure blood pressure. Sometimes it can be difficult for doctors and nurses to recognize certain sounds or to measure the blood pressure. A smart health measurement device, specific for the screening and triage of patients, can help doctors and nurses to recognize specific body sounds and makes it possible to analyze the blood pressure easier. The collection and decision support of patient data is also one of the opportunities of the smart health measurement devices.

2.2.2 Business Model Canvas

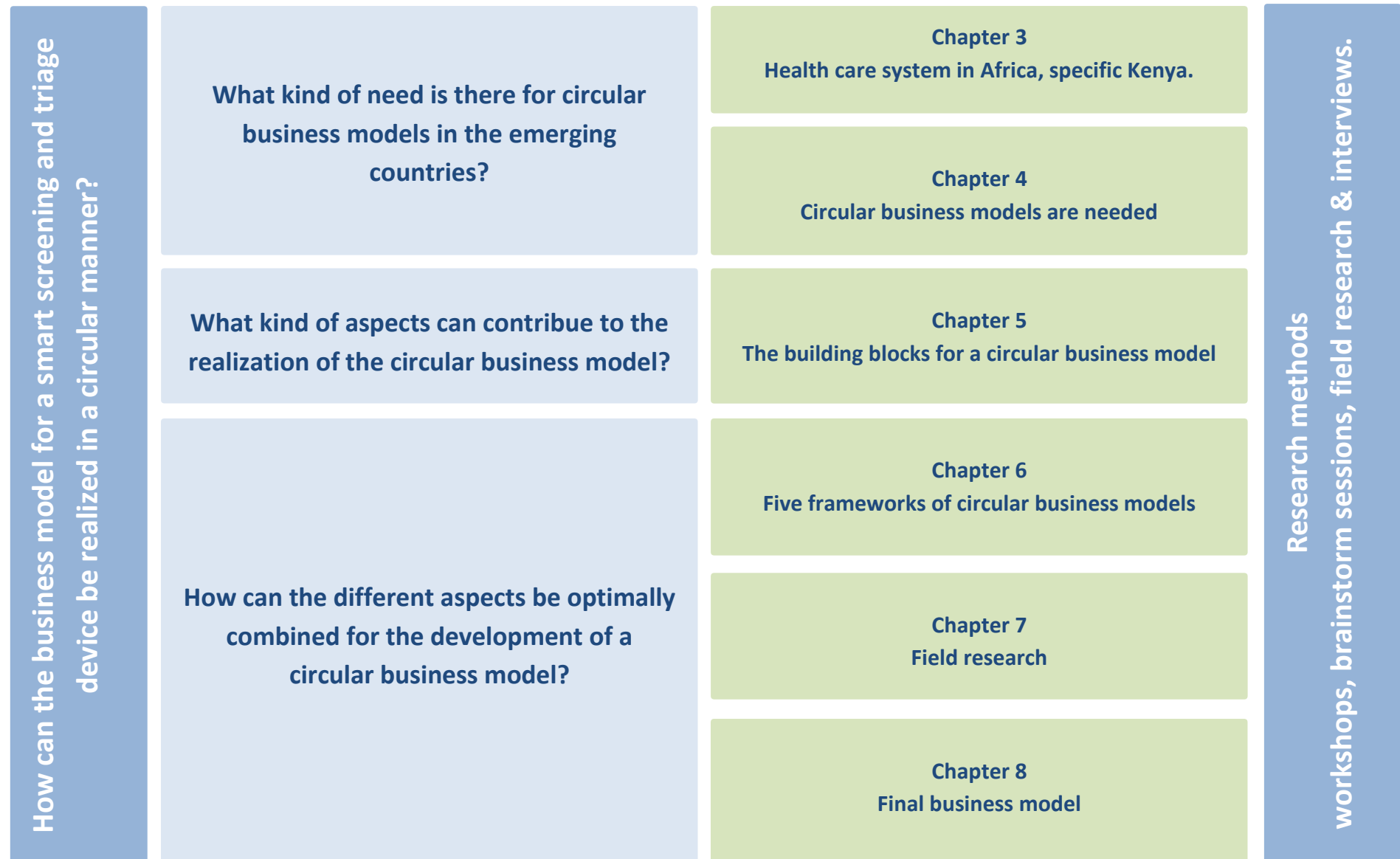
During the bachelor study and internships the Business Model Canvas was used a lot; therefore this model will be used in this research. Within Philips this tool is used frequently. This tool is used in combination with the circular economy overview of the Ellen MacArthur Foundation. Within the different elements of the Business Model Canvas, different choices can be made which can have a positive effect on the development of a more circular business model. For example, the aspect of local education; the education and training of local repairers can extend the lifetime of a product, because local people are able to maintenance and repair defects.

2.2.3 Kenya

In the first week of the research a workshop has been organized with the expert network, during the workshop was decided to focus on Africa. There are two reasons to focus specifically on Africa. First there is a clear need for a smart screening and triage device and second there is a clear landing spot for the research, because there are some ongoing projects in Africa. The focus will be mainly on the Kenya healthcare market, because the healthcare environment and infrastructure is better organized in Kenya than most of the countries in Africa. Also Philips already developed a community life center (CLC) in Kenya.



2.3 Research process



3. Health care system in Africa, in specific Kenya



Kenya is a developing country in East Africa, with a total population of 44,354,000 (Global Health Observatory, 2013). The growing middle class in Kenya has shifted the attention from physiological needs (food and shelter) towards more safety needs, like access to better healthcare (ESPAS, 2011). In this chapter are the public and private healthcare sector in Kenya discussed.

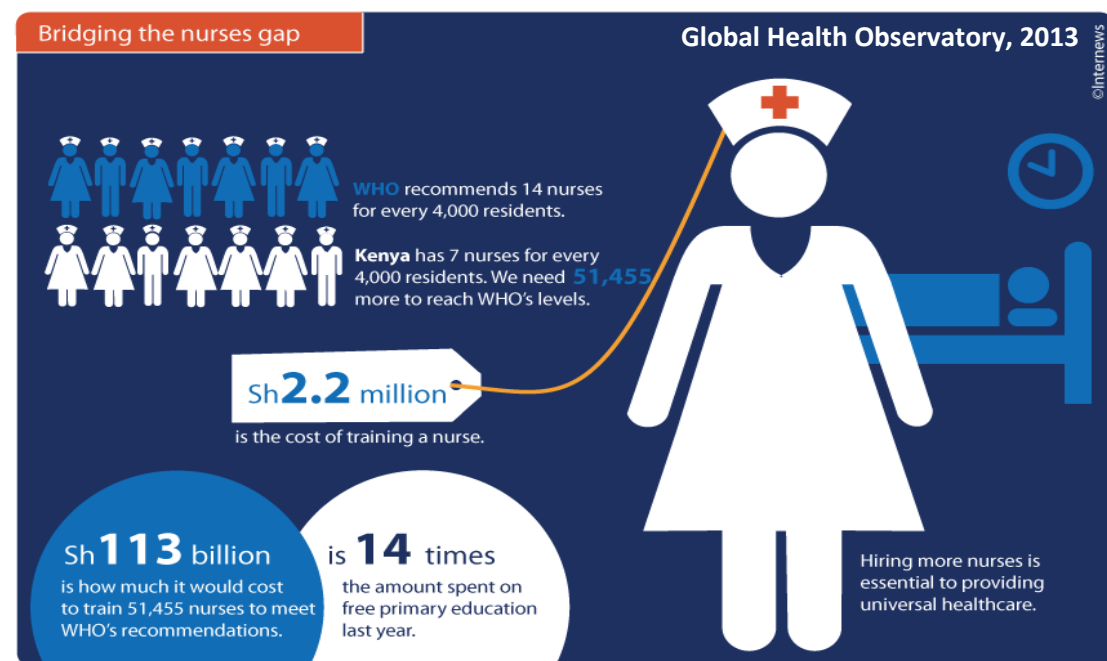
3.1 Public healthcare

Kenya has improved the healthcare system, which led to better healthcare service for infants and children under 5 years old. The life expectancy of a Kenyan at birth has improved from a low of 45,2 years (both sexes) in the 1990s to an estimated 60 years by 2012 (World Health Organization, 2014). In spite of those improvements Kenya has not succeeded in meeting its health MDG (Millennium Development Goals) targets. This is the result of the disparities in the healthcare system, closely linked to the gender, geographical and socioeconomic disparities (World Health Organization, 2014).

3.1.1 Kenya Health Policy (2014-2030)

The Kenyan government wants to improve the living standard in Kenya, by providing better education and healthcare. The Kenyan government has developed a long term policy, the Kenya Health Policy (2014-2030), which focusses on the long term intent in healthcare. This policy must lead to a better level and distribution of healthcare in Kenya. There are some specific targets in the Kenya Health Policy, for instance a 25% reduction of health illness, a 16% improvement in life expectancy and a 50% reduction in annual mortality (World Health Organization, 2014).

• Total population (2013)	44,354,000
• Gross national income per capita	2,250 (dollar)
• Life expectancy at birth m/f	59/62
• Total expenditure on health as % of GDP	4.7
• Total expenditure on health per capita	84
• Probability of dying (15/60 years)	307/261 (per 100.000)



3.1.2 Bill of Rights

Every Kenyan has a right to healthcare; this is confirmed by a recent comprehensive law, the Bill of Rights. The healthcare system in Kenya consists of a two-tier system, namely the National Government and the 47 devolved County Governments. The devolved County Governments have an important role in the healthcare system, the counties are the units of service delivery and resource allocation (World Health Organization, 2014).

3.1.3 Shortage of well-educated health workers

The shortage of well-educated health workers is one of the reasons for the poor healthcare service in emerging countries (The World Health Report, 2006). According to recent research of the WHO (World Health Organization, 2009), it is estimated that the current workforce in some of the most affected countries in Africa would need to be scaled up by as much as 140% to meet international health development targets. The figures 3.3 (overview of diseases) and 3.4 (overview of healthcare workers) show that currently the healthcare is not divided fairly.

3.1.4 Kenya Essential Package for Health

The Kenyan government has combined various programs into one package of interventions. This package needs to improve the health status of the population in Kenya. The health policy is defined in to 4 distinct levels of care (Ministry of Health, 2012);

- **Community level** (community)
- **Primary care level** (health centers & nursing homes)
- **Country level** (first and secondary level of hospitals)
- **National level** (tertiary level, specialized)

The community level delivers specified supply services that are effectively delivered at the community. The primary care level provides the first physical level of the health system, comprising of health centers, maternity and nursing homes. Most clients health needs should be addressed in the primary care level (Ministry of Health, 2012).

The first and secondary level of hospitals are part of the County level, this level delivers a more comprehensive package of health service. The highly specialized and expensive hospitals the tertiary level hospitals are part of the National level (Ministry of Health, 2012).

3.2 Private healthcare

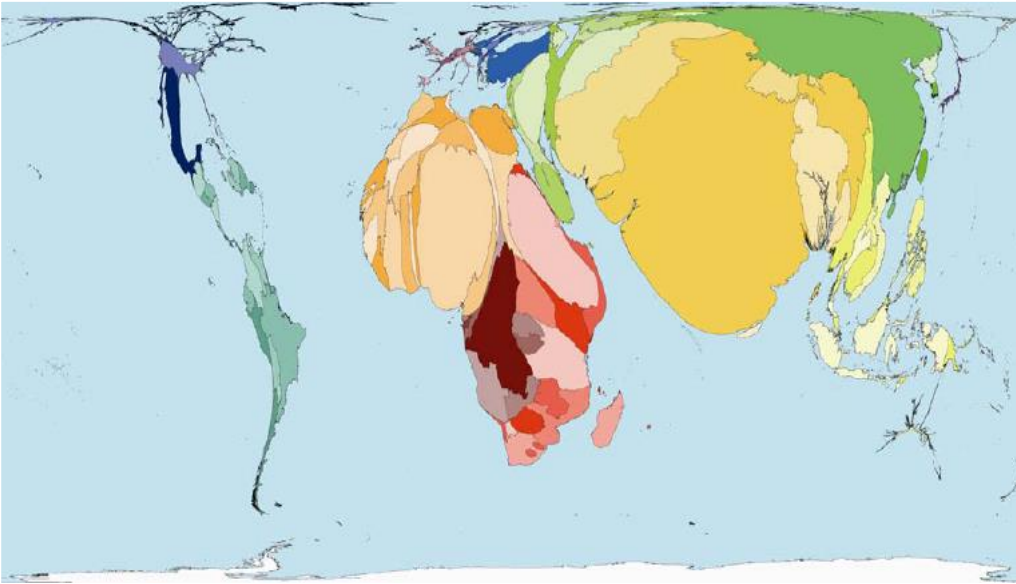
In addition to the public healthcare, facilitated by the National government and the 47 devolved County Governments, there is a private healthcare sector. The major part of the private healthcare consists of local healthcare assistants, who have built a reputation over the years. The local patients trust these local healthcare assistants and want to pay for them. The TBA (traditional birth assistant) is an example of a local healthcare assistant that works in the private healthcare sector (Maternity experience in semi-urban Kenya report, 2015).

3.2.1 Private sector is rapid growing

The private health sector in Kenya consist of 49% of the health facilities, 22% of total health expenditure is spent in private health facilities and 20% of Kenyans have health insurance (USAID, 2013). When Kenya became independent in 1963 a few private providers started, this has grown to nearly 1500 in 1993. These numbers show that the private sector is rapidly growing (Berman et al, 1995).

Figure 3.3 Where do newborn deaths occur?

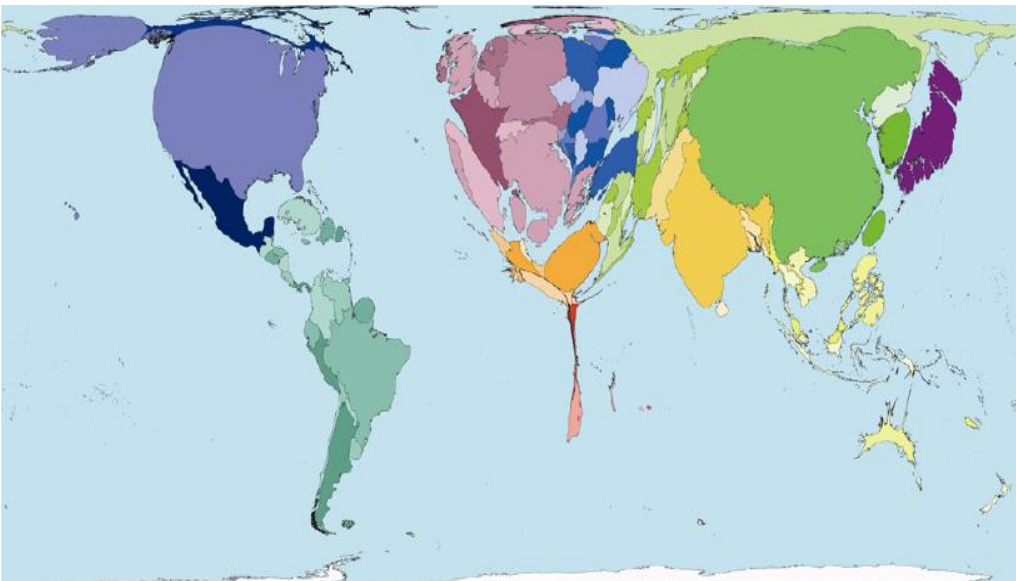
Territory size and color show the number of all newborn deaths in that territory.
(Buning, 2015)



16

Figure 3.4 Where are the world's healthcare workers?

Territory size and color show the amount of healthcare workers in that territory.
(Buning, 2015)



3.3 Suitable target market

The Kenyan government wants to improve the life expectancy with 16%, as stated in the Kenya Health Policy (2014-2030). Philips wants to help the Kenyan government to achieve their healthcare targets by creating value with its comprehensive set of connected primary healthcare solutions (Healthcare Philips, 2015).

3.3.1 Smart measurement device

Philips wants to develop a device, the Tricorder or Smart Stethoscope, for the screening and triage of hypotension and pneumonia. A standard measurement device makes it possible for doctors and nurses to screen and triage the patients by themselves. Sometimes it can be difficult for doctors and nurses to recognize certain sounds and register them. A smart measurement device has a few additional features that make it possible for less educated nurses to analyze the health conditions of patients.

3.3.2 Rural regions of developing countries

This proposed smart measurement device could help to support healthcare workers to better diagnose and manage hypotension and childhood pneumonia. This screening device can be interesting for the more rural regions of developing countries where the health infrastructure is limited (Porco et al, 2009). Recently, June 23 2014, Philips launched the first Philips Community Life Center in Kenya. This Community Life Center provides a modular community healthcare solution that easily adapts to the different community needs in the more rural regions in Kenya (Healthcare Philips, 2015). Philips wants to develop more Community Life Centers in the future.

3.3.3 Child health

The development of the smart screening and triage devices will benefit the child health, since pneumonia is responsible for 19-23% of deaths among children under 5 years old in developing countries, like Kenya (International Journal of Infectious Diseases, 2007). The patient data collected with a smart devices can be useful for the national surveillance to develop a strategy to prevent pneumonia (Black, 2002).

‘Pneumonia is a common lung infection caused by bacteria, a virus or fungi. Pneumonia and its symptoms can vary from mild to severe. Most healthy people (not in Africa) recover from pneumonia in one to three weeks, but pneumonia can be life-threatening’ (American Lung Association, 2015).

3.4 Conclusion

It is important to improve the healthcare service to achieve the healthcare targets of the Kenyan government. Philips wants to help the Kenyan government to achieve their healthcare targets by creating healthcare solutions. The shortage of well-educated health workers (see figures 3.3. and 3.4) is one of the reasons for the poor healthcare service in emerging countries.

The smart screening and triage devices (tricorder and smart stethoscope) can support healthcare workers to better diagnose and manage childhood pneumonia; therefore Philips will provide a solution for the screening and triage of hypotension and childhood pneumonia. The smart device will focus on mothers and children (<5 years) in the more rural regions of Kenya, because the most unemployed health workers are settled in the

rural regions. Now-a-days, pneumonia is responsible for 19-23% of deaths among children under 5 years old in developing countries (World Health Organization, 2014).

The screening and triage device for the more rural regions will focus on the primary healthcare in the Community level (community) and Primary care level (health centers & nursing homes). Philips is already settled in the rural regions; recently Philips launched the first Philips Community Life Center in Kenya. The Philips Community Life Center provide an optimal environment for the introduction of a smart screening and triage device, because it is settled in the rural regions and it has the potential to expand.

The Community Life Centers are part of the public healthcare system, but opportunities in the growing private sector can also be an interesting and important market to improve the healthcare in Kenya. Non-governmental organizations (NGO's) can be part of this private sector. Therefore in this research both the public and private sector will be researched. Based on the research a choice will be made which sector offers the best chance for success.

- Smart Stethoscope
- Screening and triage tool (data)
- Achieve targets Kenya Health Policy (2014-2030)
- Childhood (<5 years) pneumonia (19-23% of deaths)
- Rural regions (Philips Community Life Centers)
- Less educated health care workers



A close-up photograph of several interlocking metal gears. The gears are made of a dark, possibly steel, material and have a matte finish. They are arranged in a grid-like pattern, with some gears in sharp focus and others blurred in the background. A white rectangular box with a thin black border is overlaid on the left side of the image, containing the text '4. Circular business models are needed'.

4. Circular business models are needed

The overuse of resources, higher price levels and volatility in many markets ask for a new business model, a circular business model. The current business models are based on the traditional linear consumption patterns ('take-make-dispose'). The future of the linear consumption patterns is insecure, because of the rising demand of resources and the increasingly affluent population (Potocnik, 2013). The shift to a more sustainable society is one of the reasons for doing business in a more circular way. This part will provide an overview of the traditional linear consumption and the new way of doing business in a more circular way.

4.1 Traditional linear consumption

The traditional linear consumption focusses on selling products to a consumer, the relationship with the consumer ends by selling the product to the consumer. The manufacturer or seller is not involved in the rest of the product lifespan, therefore it only receives revenues by selling the product. This leads to a business model that focusses on take, make and dispose when it no longer serves its purpose. The manufacturer focusses on selling more and as fast as possible, this leads to overconsumption of many products.

This linear system has a big impact on the resources, waste management and environmental challenges in the world. This linear system has been used since the industrial revolution. In the future a linear system is no longer possible, because of the increasing population in the world and rising demand of resources. Therefore a new system (business model), a more closed one, is needed.



Many companies notice that the current linear system is not suitable anymore, because it increases their exposure to risks, most notably higher resource prices and supply disruptions (The Ellen MacArthur Foundation, 2013).

4.2 Circular consumption

The circular economy replaces the 'end-of-life' concept with restoration, the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products and systems (The Ellen MacArthur Foundation, 2013).

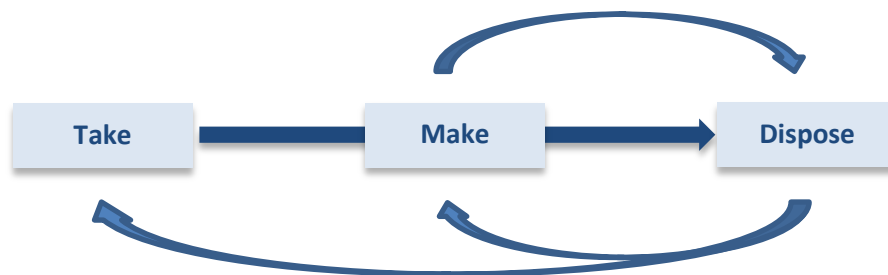
'The principle of the circular economy can be described as an economic system which focusses on the maximization of the reusability of products and the minimization of value destruction. This is in contrast with the current linear system, where products and raw materials cannot be optimally reused' (MVONederland, 2015).

A circular business model focusses not only on selling products, but on the whole service system. The manufacturer or seller not only sells a product to a consumer, but delivers a service to a user. During the whole lifecycle the manufacturer or seller will be involved and will provide service to extend the lifespan of the product. Just the extension of the lifespan of the product will not directly lead to longer use of a product. The service (repair, refurbishment and remanufacturing) provided by the manufacturer or seller is an important factor for the lifespan of the product.

There are many aspects that can contribute to the development of a circular business model, the process for optimal maintenance, repair, refurbishment and remanufacturing. To make this possible new ways of doing business are essential, a new way of ownership is needed and this will lead to a new way of financial flows.

Recently, a case study showed that lifespan management is an important factor for the lifespan and use of a product. In the case study the lifespan of two products was evaluated, namely a fridge and a laptop. Both products had an optimum lifespan of 10 years, but without any improvements or material change during the lifespan this optimum lifespan is somewhat doubtful. In four years the products were out dated and therefore not used any more. Lifespan management, like the update of technological devices can help to improve the lifespan of those products. Nowadays technology is developing very fast, so it is important to update technological products (Bakker, 2014).

This asks for new ways of value creation and managing cycles. The Ellen MacArthur Foundation describes four ways of value creation, 'power of the inner circle', 'power of circling longer', 'power of cascaded use' and 'power of pure circles'. In the following chapter circular aspects are described, which can contribute to the development of a more circular business model.



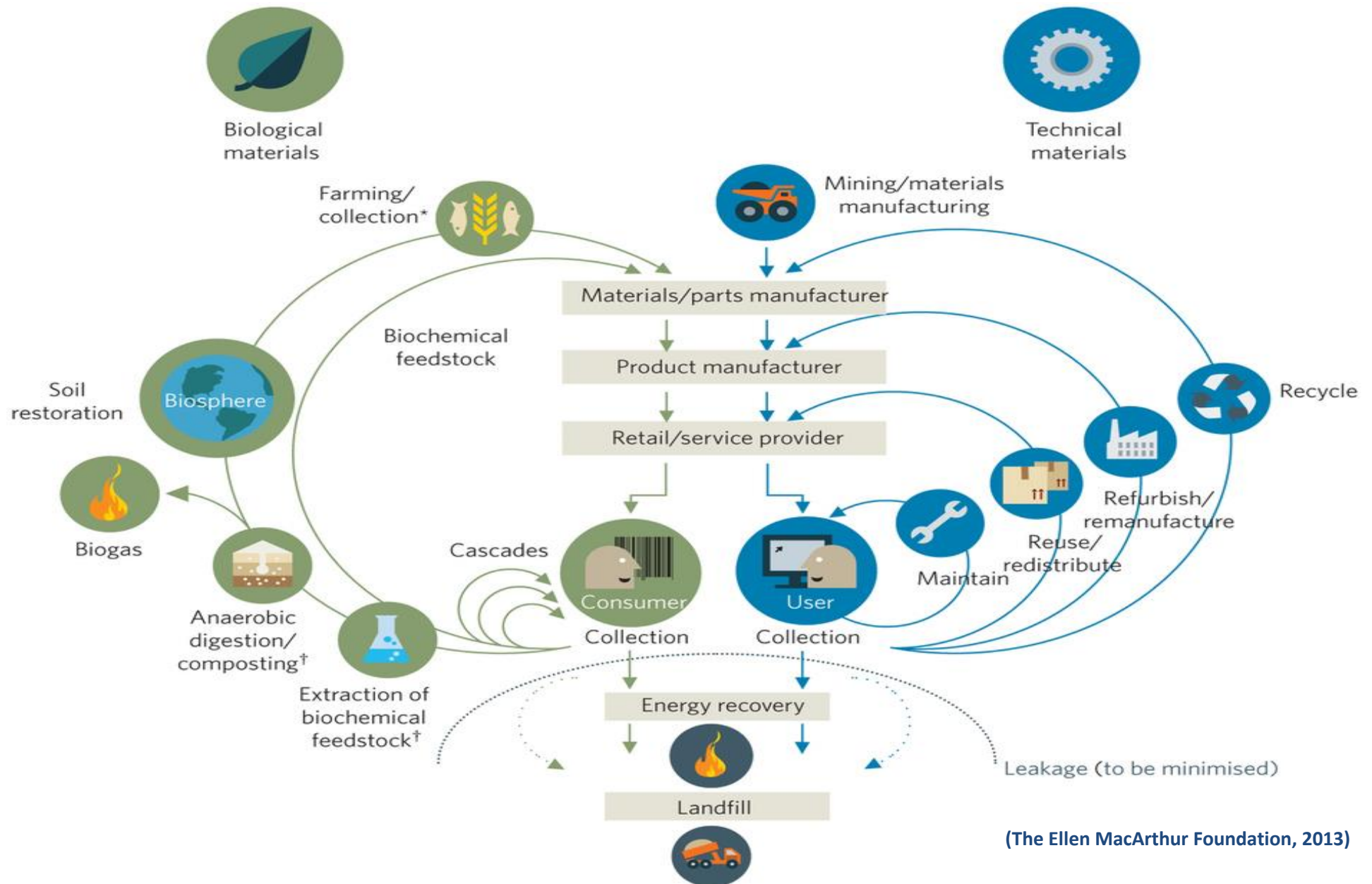
4.3 Conclusion

In this report the focus will be on the circular economy, the circular economy will be the basis for the development of a circular business model for the screening and triage devices. The circular economy can be described as a model that replaces the 'end-of-life' concept with restoration, the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products and systems, figure 4.1 gives a clear overview of the circular economy (butterfly).

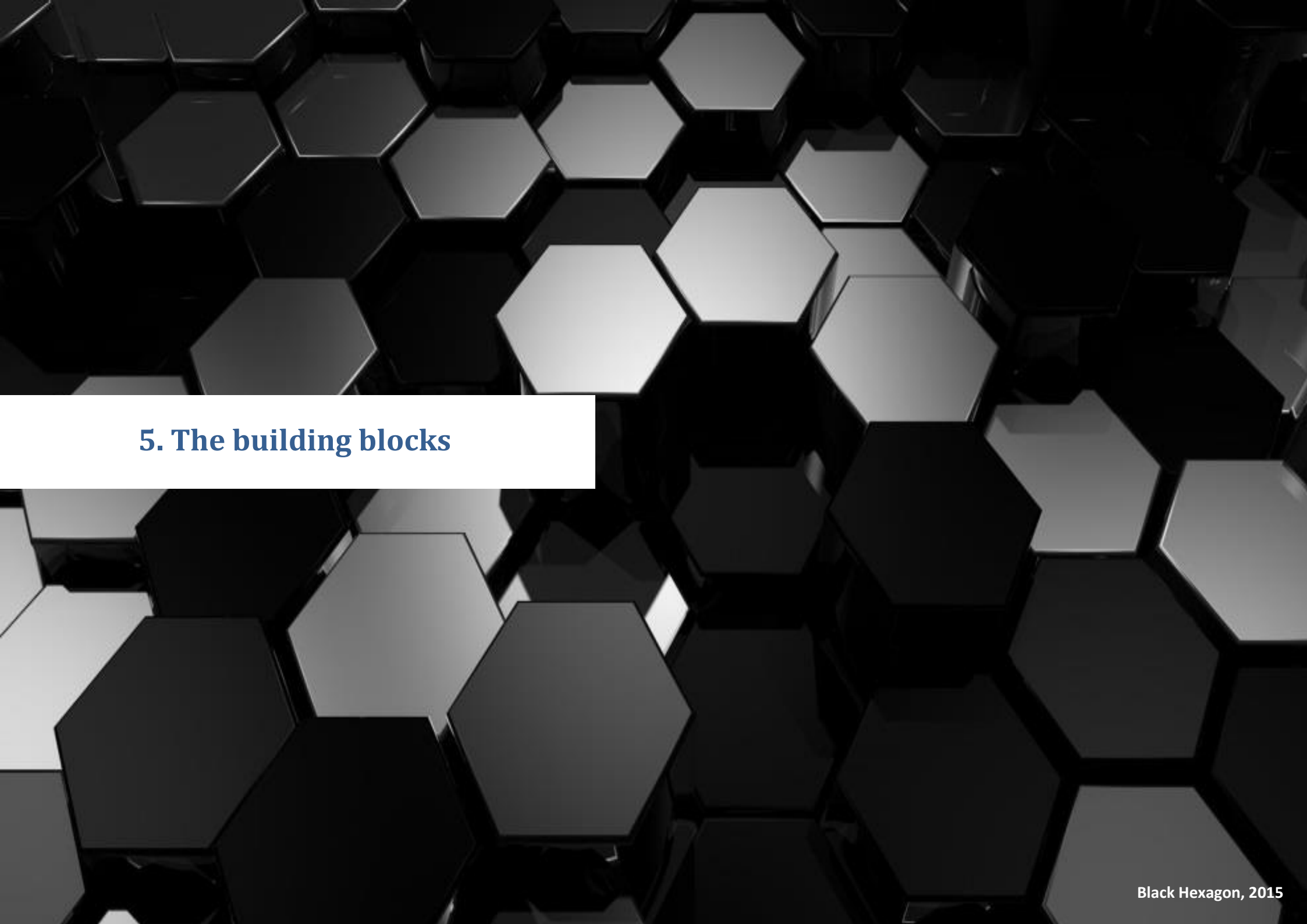
The current business models are based on the traditional linear consumption pattern. The future of the linear consumption pattern is insecure, because of the rising demand of resources and the increasingly affluent population. Next to this is the shift to a more sustainable society a reason for doing business in a more circular way. This part will provide an overview of the traditional linear consumption and the new way of doing business in a more circular way.

A circular business model focusses not only on selling products, but on the whole service system. The manufacturer not only sells a product to a consumer, but delivers a service to a user. During the whole lifecycle the manufacturer or provider will be involved and provide service for the good use and maintenance of the products. This system-based approach will be included in the development of a circular business model for the screening and triage devices.

Figure 4.1 Overview 'Butterfly' circular economy



(The Ellen MacArthur Foundation, 2013)



5. The building blocks

Current business models focus on selling products, instead of providing the whole service system around the devices. This focus reduces the opportunities for the development of a more circular business model, as described in chapter 4. In the current business models the end-of-lifespan of the product is already calculated, companies know when the consumer will come back to them for buying a new product. For this reason it is not interesting for a company to provide extra service to extend the lifespan of the product.

5.1 A new way of doing business

For the development of a circular business model companies need to focus more on the after-sales of a product and providing service to a user, instead of just selling products to consumers. The challenge is to think more in circles and systems around products. In the last few years there have been many studies on the development of new concepts. In this report I will focus on five concepts of models, the classic business concept, the hybrid concept, the gap exploiter concept, the access concept and the performance concept (Bakker et al, 2014).

5.1.1 Classic business concept

The classic business concept is the most used concept for the development of current business models. This model focusses on the basic aspects of a circular economy, the extension of the lifespan of a product (Bakker et al, 2014). This classic business concept is most suitable for products that are expensive and are used over a long time.

It can be difficult to develop a technical product that can be used over a long time, because the most technical products will be outdated after a few years (Bakker et al, 2014). To extend the lifespan of a

durable product it is important to provide a good service for the maintenance of the product, the products maintenance can help to extend the lifespan.

***The classic long life model** proposes a high-quality product with a long lifespan, with sales as the classic source of income. After-sales support contributes to quality perception. In this model, brands more often than not have a reputation of good value for money, 'it is not cheap, but never fails' (Bakker et al, 2014).*

The classic business concept can be interesting for the development of a circular business model for products in Kenya. In this concept the focus will be on producing durable products with a long lifespan. In emerging countries the durability of products is an important factor, because of the shortage of well-educated local repairers that can maintain and repair the products (U.S. Department of Commerce & International, 1990).

Next to the durability of products are the (after-sales) services, reliability, needed or desired features and aesthetics (Taku, 1999) indicators for the quality of a product. The durability of the smart screening and triage devices is important, because the health workers are not able to help patients if the devices are broken. The device provide a form of healthcare, for this reason it is necessary that the device works optimal during the whole lifespan. As described in 'The Classic long life model' aftersales services have a positive effect on the quality of the device during the whole lifespan and are important in the development of a circular business model for the smart screening and triage devices.

The extension of the lifespan of technical products is not always the most circular way of doing business, most of the technical products will be outdated after time. For the development of a circular business model for a technical product, like the screening and triage devices it is important to evaluate the status and development of the technical possibilities of the device. The replacement of the device for a more energy efficient and smarter device contributes more to a circular business model than an outdated device with a long lifespan.

In summary, the durability of the screening and triage devices is an important aspect for the development of a circular business model and delivery of good healthcare. The durability of the devices can be improved by providing aftersales services. For technical products the extension of the lifespan is not always the most circular way of doing business, most of the technical products will be outdated after time.

5.1.2 The Hybrid concept

The hybrid concept focusses on products that are dependent on replaceable part, most of the time the functional lifespan of these replaceable parts is limited. In this concept the indispensable exchangeable part needs to facilitate, as defined by the supplier, high quality functionality (Bakker et al, 2014).

In many cases, the manufacturer sells the long-lasting product at a low price and receive the profits from the sales of the indispensable exchangeable parts. These indispensable exchangeable parts have a negative effect on the development of a more circular business model, this concept generate a waste stream during the whole lifespan and makes the device dependent of other indispensable exchangeable parts.

In the more rural regions it can be difficult to deliver these parts, which makes the indispensable exchangeable parts less interesting for the development of a circular business model. On the other hand can the delivery of an indispensable service can generate a sustainable financial flow during the whole lifespan of the device.

'The hybrid model profits from the repeat sales of relatively cheap products with a short lifespan that only function together with a dedicated high-quality durable product. As examples, think of toner cartridges and coffee pads' (Bakker et al, 2014).

In the case of the screening and triage devices, the device can be linked to an indispensable datacenter (service) that analyzes the data or maintenance services. This generates a sustainable financial flow during the whole lifespan of the devices by providing an indispensable service, without producing a continuous flow of waste.

In summary, the hybrid concept provides a sustainable financial flow during the whole lifespan of the device by the delivery of indispensable exchangeable parts. In many cases these parts generate a continuous flow of waste, which has a negative impact on the development of a circular business model. For the development of a circular business model for the screening and triage devices the delivery of an indispensable service can be an interesting element to include. The indispensable services can generate a sustainable financial flow, which makes it interesting for the manufacturer to extend the lifespan of the devices.

5.1.3 The Gap Exploiter concept

The gap exploiter concept focusses on the creation of a market, without producing new products, by using existing products and the exploitation of leftover value and lifespan. In many cases these gap exploiters provide services, like repair and maintenance (Bakker et al, 2014).

The collection of old products is a new market gap. These exploiters collect old products, clean them and then sell them for a lower price than a new one. For many companies, the collection of the old products is an important aspect in their business model, because many companies started to realize the importance of a return service for their equipment. This because of the risk of information leakages and the value of the old products/components (Bakker et al, 2014). The risk of information leakage is mainly the case for technical products, like computers.

***The Gap Exploiter model** is interesting because it does not propose anything new, but feeds on value gaps in the existing system. It concerns the person in between, who repairs smartphones, sells second-hand equipment, turns CD's into candle holders, or whatever. eBay is a huge gap exploiter. Shoeshine-boys are small gap exploiters' (Bakker et al, 2014).*

The collection of the existing products and remanufacturing of these old products can be an important factor for the development of a circular business model for the screening and triage devices. The manufacturer (Philips) and the gap exploiter can operate close together to collect the old products and reuse them, which will reduce the stream of waste at the end of the lifespan.

There is a risk that the manufacturer loses some market by the sales of secondhand devices by the gap exploiter. Therefore it is important that the manufacturer operates closely together with the gap exploiter, which will makes it beneficial for both parties.

In summary, the collection of old products becomes more important, because of the risk of information leakages and the value of the old products/components. Philips can include the gap exploiter in their business model for improving the opportunities for reuse and remanufacturing. This close relationship will have a positive effect on the opportunities for the development of a circular business model for the smart screening and triage devices. Philips can reduce the risk of losing market share form the introduction of secondhand devices by working closely together with the gap exploiter.

5.1.4 The access concept

The access concept focusses on the delivery of access to services. For example access to a book in a library, instead of buying it at a bookstore. The library needs to provide the service for the customers to read the books they prefer. It is the libraries responsibility to have a good collection of books and facilities for reading the books.

The user of the library pays contribution, each month or year, to get access to the books. During the total lifespan the provider will be the owner of the product that is provided. This is only possible if it is unnecessary for the user to own the product. For example it is difficult to develop a model that gives access to bread, because it is not possible to return the bread after consuming.

The access model is interesting for expensive products. By providing a access model the service is accessible for all kinds of income groups, so also users with less money to spend will have access to the service. This concept makes it possible for more users to use this service and also to earn revenues over the total lifespan of the product. This means that the market for the product (amount of customers), and in relation the revenues, will increase by using 'The access model'.

'The access model' is about making money through providing access to a product, while its ownership remains with the access provider. The customer remains with the access provider. The customer gets to use a car (BMW), a washing machine (Miele), a room or a tool. There is a time limit and products are used in turns. The customer is concerned with the brand and with the kind of product' (Bakker et al, 2014).

In the book 'Products that last' criteria are formulated which are important to the success of a business model that focusses on providing access to a service instead of ownership. The first criterion describes the renting of the service must be significantly cheaper than buying and the service must be attractive and well maintained.

Second, is the criterion of freedom, people will do what they want or had planned to do. The identity of the products is the next criterion. Some products add to the identity of the consumer when they buy it. For this reason the access concept focusses more on products that are not related to an identity or cultural standard. Next to these criteria time is an important factor for the success of an access model. Time refers to the frequency of use by a consumer. For example a mobile crane can be an interesting product for the access concept, it is not used every day (sharing is possible). The final criterion focus is the accessibility of the

service, it should be easy for the consumers or users to get what they want or need (Bakker et al, 2014).

For the development of a circular business model for the smart screening and triage devices the access concept can be an interesting model. As described in chapter 3, there is a high demand for healthcare service in Kenya. This demand can be fulfilled by the delivery of a service (access to the devices) for a lower price than the costs of buying the whole product, which makes it affordable for more patients. In this case the ownership of the product is an important factor. The ownership of the product is also important for the maintenance of the products (who is responsible for the good use and maintenance of the products).

In summary, the access concept focusses on the ownership of the screening and triage devices. In this case the provider is the owner of the device and provides healthcare service to the patients. The lifespan of the devices is important in the access model, extending the lifespan of the devices will also extend the lifespan of the service. For the provider this makes it interesting to extend the lifespan of the devices, a longer lifespan will provide longer business. To extend the lifespan of the devices the provider will focusses on the maintenance of the devices, which has a positive effect on the circularity of the business model. The access concept provides a sustainable business for the provider, because it can reach a bigger market. (more patients are able to pay a lower price). The criteria that are described in the 'Products that last' book fit for the screening and triage devices. The concept gives patients more freedom, the product doesn't provide a form of identity and it is not used often by the same patients.

5.1.5 The Performance concept

This concept goes a step further than the access concept. Instead of getting access to a service or a product, like a library where you can borrow a book, the performance concept only focusses on the fact that the user wants to read. The customer is not interested in how the service is provided, he only wants to read.

In this case users only pay for the performance that is provided by the provider, this means that they only pay when they really want to or use it. In this concept the provider is responsible for the performance and for his own revenues (Bakker et al, 2014). The provider must decide how the performance will be provided, in this case the user is not interested in the specific product or how the service is provided.

'The performance model leaves responsibility with the provider, with earnings based on the performance provided. It is up to the provider which machinery or products are deployed to carry out the required tasks. Users are exclusively interested in the quality of the service, not in the product providing it. Examples are printing, transportation or a data cloud. At work here is the so-called inseparability principle: service are consumed at the same moment they are generated' (Bakker et al, 2014).

In the access concept the provider is the owner of the product and has the responsibility of maintaining it. In the performance concept the provider is the owner of the product and is responsible for its performance. This ownership and responsibility for the performance of the product gives the provider a positive impulse for the endurance of the product, because it can be beneficial for the provider to maintain.

It is profitable for the provider to handle the whole product value circle. This means that the maintenance, repair, upgrading, second hand parts traffic and eventually recycling are the responsibility of the provider (Bakker et al, 2014). The profitability of handling the whole product cycle, makes it interesting for the provider to extend the lifespan of the product and facilitate the recycling of components. This has a positive effect on the circularity of the business model. The performance concept is an interesting way of doing business in a more circular way.

For the development of a circular business model for a screening and triage device the performance concept is an interesting way of doing business. In this case the patients will pay for the performance that is delivered by the screening and triage devices. It is the responsibility of the provider that the devices work well and deliver the expected performance.

In summary, the performance concept has a positive effect on the circularity of a business model. The provider is responsible for the performance of the provided service (usages of devices). In this case it is profitable for the provider to handle the whole product value circle, which means that the maintenance, repair, upgrading, second hand parts traffic, and eventually recycling are the provider's responsibility. For the development of a circular business model for the screening and triage devices the performance concept is interesting. It makes the provider responsible for the performance of the devices. For this reason the will provider focusses on the maintenance of the devices. In this case the ownership of the device and its maintenance are important aspects.

5.1.6 Conclusion

The five concepts that are described in this part, the classic business concept, the hybrid concept, the gap exploiter concept, the access concept and the performance concept (Bakker et al, 2014) are concepts which include elements that can contribute to the development of a circular business model. Each concept has a different element which can be useful for the development of a circular business model.

The durability of the devices (classic business concept), aftersales service support (classic business concept), the delivery of indispensable service (the hybrid concept), a good relationship with secondhand dealers (the gap exploiter concept), the way of providing service (the access concept), a new way of ownership (the access concept) and paying for the results of the devices instead of the whole product (the performance concept) are elements that are important for the development of a circular business model, specifically for a screening and triage device in Kenya.

These elements focus on a future where private ownership is not the norm anymore. The economy is shifting more to a business model that focusses on sharing, using and performance based service delivery. These concepts are very interesting for the development of a circular business model. It provides a new way of ownership, which makes it interesting for providers to extend the lifespan of products and provide a sustainable financial flow during the whole lifespan. It encourages providers (owners) to handle maintenance, repair, upgrading, second hand parts traffic, and eventually recycling for their products to sustain a financial flow. This more circular focus can help to overcome the environmental challenges the society is facing and put a hold on the rising demand for resources.



5.2 Value creation

The necessity of a circular business model is described in chapter 4, 'A new business model is needed'. In the 'Toward the circular economy' report of The Ellen MacArthur Foundation four sources of value creation are described that can offer many opportunities in comparison with the linear production and consumption. These four sources of value creation are useful for the development of a circular business model. The four sources are the power of the inner circle, circling longer, cascaded use and pure cycles. These will be described in more detail further on.

5.2.1 Power of the inner circle

The power of the inner circle focusses on the reuse of products. The scope of the circle is an important factor for the optimal reuse of products. A closer and smaller circle makes it possible that less product changes are needed to maintenance, reuse, remanufacture and recycle the products. These small changes will lead to potential savings on the labor, energy, capital and material needed to reuse the product.

*'The **'power of the inner circle'** refers to minimizing comparative material usage vis-à-vis the linear production system' (The Ellen MacArthur Foundation, 2013).*

A good relationship and close contact with all the key partners and channels in the business model make it possible to develop a closer and smaller circle. The provider can communicate easily and fast with the partners and this makes it possible to distribute faster and get the right resources from suppliers. These close circles have a positive impact on the reuse of the products and with that a positive effect on the circularity of the business model.

The power of the inner circle is an important factor for the development of a circular business model for the smart screening and triage device in Kenya. A tighter relationship with all the stakeholders of the devices will improve the opportunities for reuse, refurbishment and remanufacturing, because less product changes are needed. This has an impact on how fast the devices can be returned for use, on how many patients can be screened and on the potential savings of material, energy and capital.

In summary, the power of the inner circle focusses on the development of a tighter circle. The tighter circle makes it possible to easily reuse, refurbishment and remanufacturing devices, without making big product changes. This makes it possible to provide potential savings on material, energy and capital.

5.2.2 Power of circling longer

The power of circling longer focusses on the longer use of materials, components and products. This circle is necessary to meet the different challenges in the future, like the rising resources prices, operation and maintenance costs. The circle can expand by implementing multiple consecutive cycles or by spending more time within a cycle (The Ellen MacArthur Foundation, 2013). The circling longer makes it possible to use materials, products and components longer within the circular business model.

A closely related way how companies can benefit from the power of circling longer is to maximize the number of consecutive product cycles (cycles of repair, remanufacture, or reuse) and the time products spend in each of them (Nguyen et al, 2014). Leasing is a good example of the

extension of the use of the products or components. The provider wants the product lifetime to be as long as possible.

*'The **'power of circling longer'** refers to maximizing the number of consecutive cycles (be it reuse, remanufacturing, or recycling) and/or the time in each cycle' (The Ellen MacArthur Foundation, 2013).*

A longer lifetime will provide a sustainable financial flow when a company leases their products. A mobile phone normally can be used for 1 years (for example), but the principle of the power of circling longer focusses on how the mobile phone can be used for more than 3 year. To make this possible the power of circling longer focusses on the reuse of identical products and materials within the circular setup.

The power of circling longer is useful for the development of a circular business model for a screening and triage device. A smart screening and triage device can be part of one refurbishment cycle, which makes it difficult to reuse the devices in the long run. Multiple or consecutive cycles can improve the possibility for reuse, refurbishment and remanufacturing of the devices. The use of multiple cycles improves the opportunities for a more circular business model.

In summary, the power of circling longer contributes to the development of a circular business model. This aspect focusses on the reuse, refurbishment and remanufacturing in a multiple of consecutive cycles. The extension of the circle can be done by implementing multiple consecutive cycles or by spending more time within a cycle. The circling longer makes it possible to use materials, products and components longer within the circular business model.

5.2.3 Power of cascaded use

The power of cascaded use is another source of value creation. This principle focusses on the reuse of products or components which are diversified more widely across the value chain. The power of cascaded use is linked to the ability to collect majority of items which are dispatched to the global secondhand-apparel markets (Nguyen et al, 2014). The power of cascaded use focusses mainly on products or components that can safely be returned to the biosphere, like clothes, coffee and other biological products.

*'The **'power of cascaded use'** refers to diversifying reuse across the value chain' (The Ellen MacArthur Foundation, 2013).*

The 'power of circling longer' focusses on the reuse of identical products and materials within the circular setup for a specific product. The power of cascaded use focusses more on the arbitrage opportunity in the cascading of products, materials and components across different product categories (The Ellen MacArthur Foundation, 2013).

'Global apparel retailer H&M launched an in-store collection program encouraging customers to bring in old clothes in exchange for discount vouchers on new H&M clothing. (Nguyen et al, 2014).

The power of cascaded use is an interesting aspect for the development of a circular business model. The reuse of products or components more widely across the value chain makes a sustainable model more realistic. This cascaded use will provide a new financial flow from more widely available markets, which will stimulate the provider to reuse the materials, products or components in a more broader way to expand their revenues. This cascaded use is useful for the development of a circular

business model for the smart screening and triage devices. The devices will be used for a new purpose at the end of the lifetime. For example, the battery of the screening and triage devices can be used as an (extra) external battery for the charging of mobile phones.

In summary, the power of cascaded use focusses on the reuse of products and components more widely across the value chain. The focus is more on the arbitrage opportunity in the cascading of products, materials and components across different product categories.

5.2.4 Power of pure inputs

The power of pure inputs focusses on the production of non-toxic products (or at least easier-to-separate inputs and designs). The products need to be produced in such a way that toxic chemicals are not needed or in a smaller amount. The lower amount of toxic chemicals used in the product makes it easier to reuse the product, because the chance is bigger that the products are not polluted during the lifespan.

*'The **'power of pure circles'**, finally, lies in the fact that uncontaminated material streams increase collection and redistribution efficiency while maintaining quality, particularly of technical materials, which, in turn, extends product longevity and thus increases material productivity' (The Ellen MacArthur Foundation, 2013).*

The opportunity for reuse of products and components can be improved by designing the products in such a way that technical and toxic materials can be separated easily in different components. Better identification of the products and a robust design reduce the product damages during the collection and transportation.

Those improvements translate to future reductions of the comparative costs of the reverse cycle while maintaining nutrients (technical) at higher quality throughout the cycles (The Ellen MacArthur Foundation, 2013). The lower amount of toxic will improve the possibilities for reusing the materials, this has a positive effect on the development of a circular business model.

'Even in paper recycling (where the inputs are generally considered "pure" and recycling rates approach 80 percent in Europe), the difficulty of removing inks, fillers, and coatings from paper without degrading it results in a loss of materials worth \$32 billion a year' (Nguyen et al, 2014).

For the development of a circular business model for screening and triage devices the power of pure inputs is an interesting approach to increase the opportunities for recycling and remanufacturing of the devices. The devices need to be designed in such manner that the devices can be taken apart easily. Batteries are components of technical devices that include toxic chemicals. To increase the lifespan of the batteries the flow of toxic components will be reduced. In this case renewable energy is a good alternative, like an electric wind-up mechanism.

In summary,

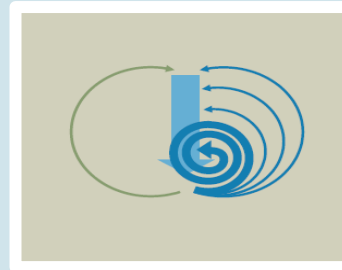
Recycling and remanufacturing are two important aspects of the circular economy, for that reason these aspects are important for the development of a circular business model for the smart screening and triage devices. The opportunities for recycling and remanufacturing of the devices are increased by the use of pure circles.

5.2.5 Conclusion

The four sources of value creation which are described in the 'Toward the circular economy' report of The Ellen MacArthur Foundation provide a clear overview of aspects that can contribute to the development of a circular business model. The four sources of value creation are; power of the inner circle, power of circling longer, power of cascaded use and power of pure cycles. These four together are a solid base for a circular business model.

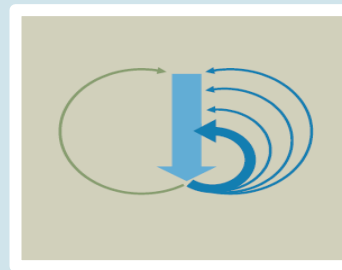
The power of the inner circle focusses on the reuse of products. The scope of the circle is an important factor for the optimal reuse of products. A closer and smaller circle makes it possible that less product changes are needed to maintenance, reuse, remanufacture and recycle the screening and triage devices. The power of circling longer focusses on the longer use of the materials, components and devices. The circling longer makes it possible to use the materials, devices and components longer within the circular business model. The power of cascaded use is another source of value creation. This principle focusses on the reuse of the screening and triage devices or the components which are diversified more widely across the value chain. The power of pure inputs focusses on the production of non-toxic products (or at least easier-to-separate inputs and designs). Products need to be produced in such a way that toxic chemicals are not needed or in a smaller amount, this makes the reuse of products, materials and components easier.

The power of the inner circle, the power of circling longer and the power of pure inputs are the most interesting for a business model. They can be implemented in each business model. The power of cascaded use focusses more on products which can safely be returned to the biosphere, like clothes and coffee.



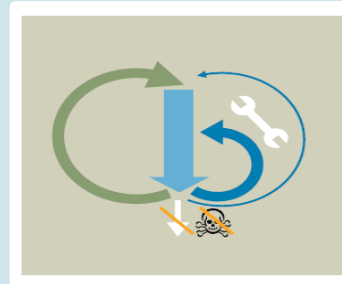
Power of the inner circle

'The 'power of the inner circle' refers to minimizing comparative material usage vis-à-vis the linear production system' (The Ellen MacArthur Foundation, 2013).



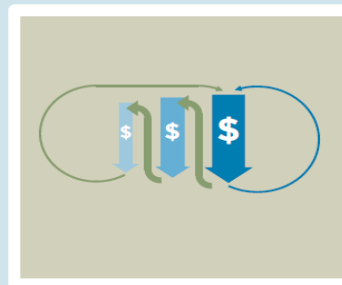
Power of circling longer

'The 'power of the circling longer' refers to maximizing the number of consecutive cycles (be it reuse, remanufacturing, or recycling) and/or the time in each cycle' (The Ellen MacArthur Foundation, 2013).



The power of pure inputs

'The 'power of pure circles', finally, lies in the fact that uncontaminated material streams increase collection and redistribution efficiency while maintaining quality, extends product longevity and thus increases material productivity' (The Ellen MacArthur Foundation, 2013).



Power of cascaded use

'The 'power of cascaded use' refers to diversifying reuse across the value chain' (The Ellen MacArthur Foundation, 2013).

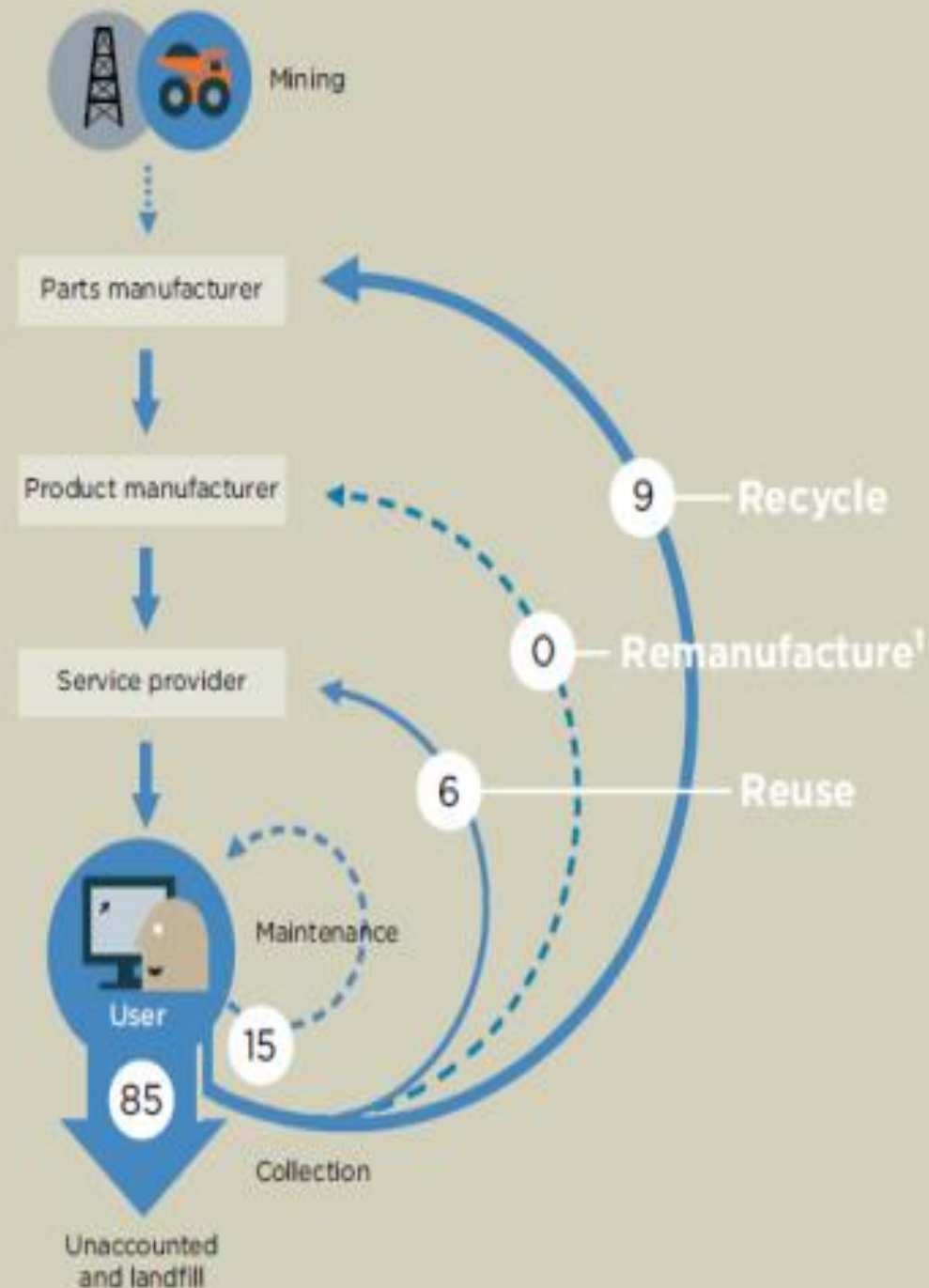
5.3 The butterfly

In many reports 'the butterfly' of The Ellen MacArthur Foundation is described. This 'butterfly' gives a clear overview of the possible closed cycles. The 'butterfly' exists of two parts: the biological materials and the technical materials. In this research the focus will be mainly on the right-side (the technical materials) and especially the technical parts of the smart screening and triage devices.

The right wing of the 'butterfly' focusses on the maintenance, reuse/redistribute, refurbish/remanufacture and recycling of technical materials. The key partners in this cycle are the manufacturers of the materials and components of the products. For the development of a circular business model, especially for technical materials, those aspects of the butterfly are useful. In this part the aspects maintain, reuse/redistribute, refurbish/remanufacture and recycling will be described more in detail.

5.3.1 Maintenance

The maintenance of products, materials and components focusses on the repair and good use of it. In the right wing of the 'butterfly' the maintenance of the device is the most efficient way to retain or restore the product to its desired level of performance. The maintenance of products is a source of competitive advantage and can expand business opportunities by providing better after-sales service. The maintenance of products is described as the protection of the equipment from further damage, pollution prevention and personal safety (Gandhi, 2007).



The maintenance of products, components and materials provides many benefits: it increases the lifespan of the product, is a source of competitive advantage and provides new business opportunities (Armistead and Clarke, 1992). These advantages can generate three times more turnover (Wise and Baumgartner, 1999) and they can prevent pollution and waste disposal (Ajukumar and Gandhi, 2012).

The maintenance of a product can extend its lifespan. For this reason the maintenance of a product is an important aspect for the development of a circular business model. The extension of the lifespan of a product reduces the request for resources: less devices need to be produced (the device can be used longer). The decrease of the manufactured products has an impact on the total waste at the end of the lifespan of the products.

The maintenance of a product includes after-sales services, repair, servicing, diagnostics (onsite and remote), technical support (documentation and personal), installation, warranty, courtesy replacement products and cleaning (circulareconomytoolkit, 2015). These aspects should be included in the circular business model for the screening and triage devices.

In summary, the maintenance of screening and triage devices extends the lifespan of the devices. For the development of a circular business model the maintenance of the devices is an important aspect. The maintenance of the devices needs to be included to extend the lifespan of the devices. It is necessary to evaluate which partner (stakeholder) provides the best maintenance service for the devices. In this case it is possible for Philips to do the maintenance of the devices (service contract) themselves.

5.3.2 Reusability

The reusability of a product is an important aspect of the circular economy. A product that can be reused optimally will produce less waste than a product that cannot be reused. By optimally reusing existing technologies and materials, significant benefits (see figure 5.3.2) can be made, cost, time, product quality, and performance benefits (Duffy and Ferns, 1999). In the field of reusability of a product there are three types for reusing a product: figure 5.3.1 gives a clear overview of these types of reuse.

‘The use of a product again for the same purpose in its original form or with little enhancement or change. This can also apply to what Walter Stahel calls ‘catalytic goods’, e.g., water used as a cooling medium or in process technology’ (The Ellen MacArthur Foundation, 2013).

First of all there is, the **end-of-life** product reuse (type 1). This concept refers to the reuse (recycling) of products or components so that the materials can return to the product’s life cycle. This reuse (recycling) at the end-of-life of products will result in savings of natural resources and reduction of environmental impacts (Hata et al, 1997; Kimura et al, 1998).

Second type is, the reuse of **existing manufacturing resources** (type 2). For the manufacturing of products a lot of resources and energy are needed, especially when the process (manufacturing equipment) has to be upgraded, reconfigured or redesigned. Therefore many savings of natural (and financial) resources and reduction of energy (environmental impacts) can be made by designing the products in such a way that the manufacturing process can be reused and shared for other products (Kimura and Nielsen, 2005).

Final type is, the reuse of **product information and design knowledge** (type 3). The reuse of product information and design knowledge is a prerequisite for the earlier two types of reuse. The reuse of available resources is only possible if the product is designed in such a way that they can be reused (Ong, 2008). Figure 5.3.1 provides a clear overview of the three types of reusing.

These three aspects need to be included in the circular business model for a screening and triage devices. Hereby the business model will mainly focusses on how to increase the possibilities to reuse the product at the end-of-life. The reuse of existing manufacturing and design knowledge are things that are too specific for this research. In this research the focus will only be on the development of a circular business model. For that purpose the reuse at the end-of-life is the most interesting.

Insummary, the reusability of the screening and triage devices can improve the opportunities for the development of a circular business model. The reuse of the devices or components of the devices will reduce the waste flow after the use of the devices and at the end-of-life. By optimally reusing existing technologies and materials, significant benefits (see figure 5.3.2) can be achieved, namely cost, time, product quality, and performance benefits. There are three types of reuse, which are described more in detail in this chapter. For the development of the circular business model these types of reusability are important, which are: the end-of-life product reuse, reuse of existing manufacturing resources and reuse of product information and design knowledge. For the development of a circular business model for the screening and triage devices the focus will be mostly on the reusability at the end-of-life of the devices.

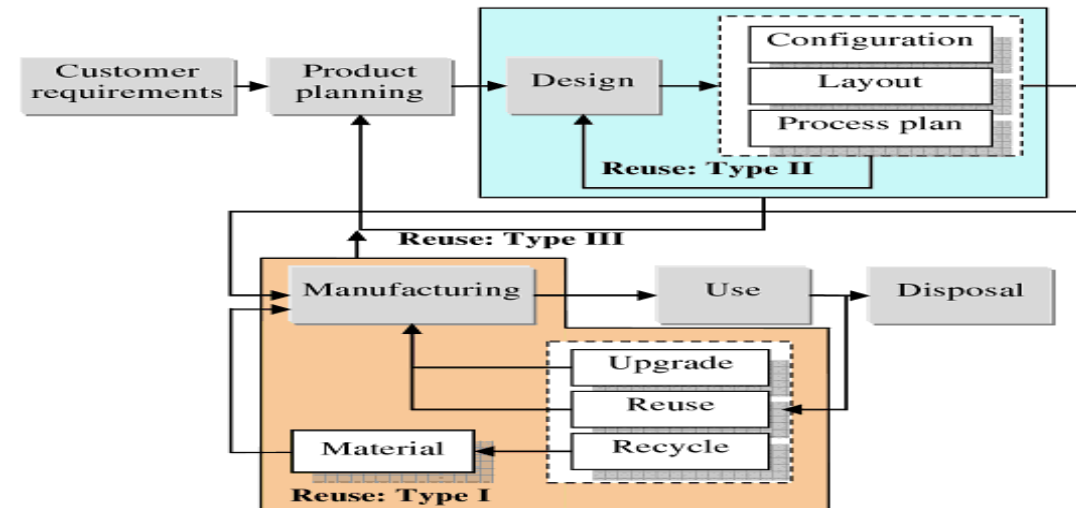


Figure 5.3.1 Type of design reuse in the product life-cycle (Ong, 2008)

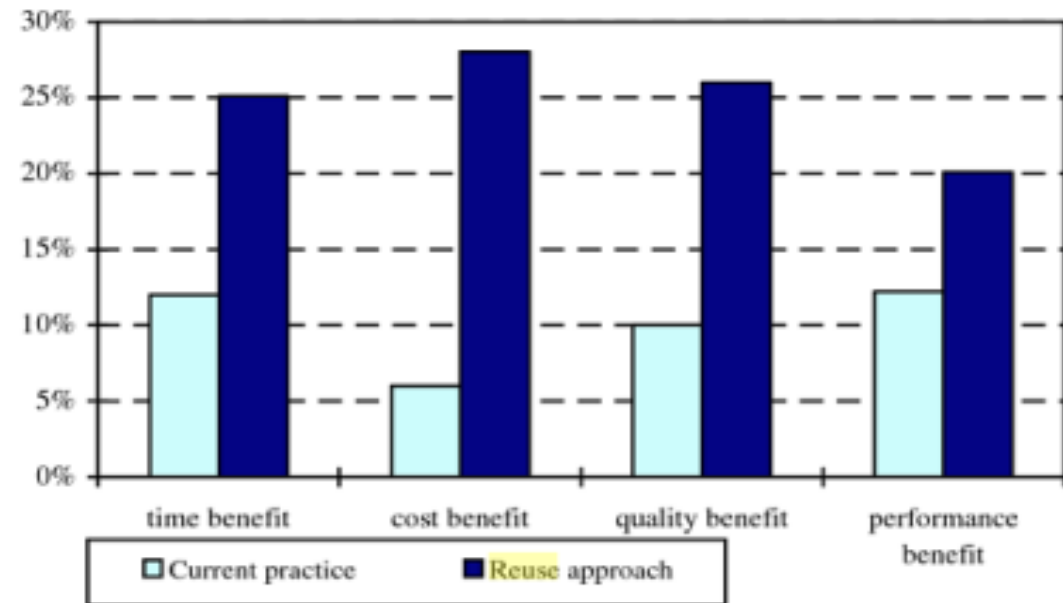


Figure 5.3.2 Current and foreseeable benefits of design reuse (Duffy and Ferns, 1999)

5.3.3 Remanufacture

The remanufacturing makes it possible to extend the lifetime of a product. Re-manufacturing can be described as an upgrade or renewal of an existing product. The remanufacturing of products can be very interesting when the resources are scarce or when the product is very expensive.

The cost of labor is an important factor for the opportunity to remanufacture a product. Lower labor costs can have a positive effect on the opportunities for the remanufacturing of a product. In developed economies remanufacturing is not successful, because of the expensive labor and repair costs (Ashby, 2015). There are many opportunities for developing countries in the field of manufacturing of existing products, because of the low labor costs and the scarce resources.

'A process of returning a product to good working condition by replacing or repairing major components that are faulty or close to failure, and making 'cosmetic' changes to update the appearance of a product, such as cleaning, changing fabric, painting or refinishing. Any subsequent warranty is generally less than issued for a new or a remanufactured product, but the warranty is likely to cover the whole product (unlike repair). Accordingly, the performance may be less than as-new' (The Ellen MacArthur Foundation, 2013).

To improve the opportunities of remanufacturing of products there are some design requirements, namely easy access and separation, easy identification of components and easy verification of condition. These design requirements will be described more in detail.

Easy access and separation

The possibilities for remanufacture are optimal when the devices are easy, fast and cheap to disassemble (Ashby, 2015). The way in which a device needs to be disassembled has an impact on the remanufacture costs. The labor costs will increase when it takes too long to disassemble the device and that makes it too expensive to manufacture the devices.

Easy identification of components

The disassembled device will consist of many parts or components. To improve the remanufacture process it is important that the components are easy to identify. Assemble numbers will improve the possibilities for remanufacture, because it helps to easily identify the different components of the devices (Ashby, 2015). Design continuity increases the number of interchangeable parts between different models in the same product line (Nilsson, 2007).

Easy verification of condition

Before the manufacture of a device starts it is important to (pre-check) evaluate the quality of the device (L. Camarinha-Matos, 1998), because it must be efficient to remanufacture the device (otherwise recycling of the components is better). Embedded monitors or systems that record use-history are useful to easily verify the condition of the devices. This will help to predict the residual life and thereby the added value of remanufacturing (Ashby, 2015).

Remanufacturing process and collaboration

The remanufacturing process consists of many processes. These processes are divided in external and internal processes. In figure 4.2.2 you can find an overview of the remanufacturing process displayed.

Figure 5.3.3 Remanufacturing process and collaboration

Design

The remanufacturing of the screening and triage devices will be most cost-efficient and sustainable when the devices are specifically designed for remanufacturing. As previously described, some aspects are important for the remanufacturing of the devices, namely how easy it is to disassemble and reassemble, use of more durable material, if the parts are easy to recover and test and standardized as far as possible (Hauser and Lund, 2012).

External in process (Collect and Cores)

The 'External in': process consists of taking care of the collection and input of the devices or components that are useful to remanufacture. The devices and components will be evaluated, also called pre-check, before they will be collected, because not all used devices qualify for remanufacturing. Delivery of the devices or components can take place in different forms; the consumer delivers when buying a new product (occasions), salvage operators and rental (end of lease) units (Nilsson, 2007).

Internal process

The internal process contains the needed manufacturing steps to recondition the incoming cores to the needed quality level. To perform remanufacturing it is necessary to build up the whole remanufacturing system, not only the actual remanufacturing activities. The process includes several steps, namely: inspection, cleaning, disassembly, reprocessing, reassembly, testing and storage (Sundin, 2014).

External out process (Remanufactured products to consumers)

The 'External out': distributing the output of remanufactured devices to customers. The distribution to the consumer can take place in many forms. Often the market area for remanufactured products is different from those of new products. A few measures can provide a stable market for the remanufactured components, namely offer credible quality (longer guarantee), offer lower pricing and use the components in new products (Matsumoto et al, 2011).

The remanufacture and refurbish (update) of products are important aspects for the development of a circular business model for a screening and triage device. In specific for the development of a business model in emerging economies, like Africa. There are many opportunities for developing countries in the field of manufacturing of existing products, because of the low labor costs and the scarce resources (Ashby, 2015). This in comparison with developed countries where the labor and resource costs are much higher.

To improve the opportunities of remanufacturing of products there are some design requirements, namely easy access and separation, easy identification of components and easy verification of condition. Those aspects or requirements are important factors for the opportunities of the development of a circular business model, because the possibilities for remanufacturing increase the lifespan of a product by updating the product so it can be used for another purpose of market.

In summary, the remanufacturing or refurbishment of the devices is an important aspect for the development of a circular business model. The remanufacturing of the devices extends the use of the devices and the components. Next to the environmental sustainable issues will the longer use of the devices also have an impact on the healthcare conditions in Africa, longer use makes it possible to screen and help more patients. Therefore these aspects will also be involved in the development of the circular business model for the screening and triage devices. The remanufacturing of products is most beneficial in the emerging markets, because there the costs of labor are lower than in the developed markets. The main target for the screening and triage devices are emerging markets, so it is a suitable market for remanufacturing the devices.

5.3.4 Recycle

The original expected functionality of a product cannot be delivered at the end-of-life of a product, therefore it is not possible to remanufacture the product or reuse it. In this stage, end-of-life, it is only possible to recycle the components of the product. In this case it is important to know which components can be used for the secondhand market, and to whom the components can be sold. For the development of a circular business model for screening and triage devices it is important to include the recycling of components of the devices. The opportunities for recycling of the devices are dependent on the collaboration with other stakeholders for the collection, selling and buying of the components. In the circular business model for the screening and triage devices the recycling of the components at the end-of-life must be included.

In summary, a clear overview of the recycling process can improve the circular aspects of the business model. The way of collecting, selling and buying of the components must be planned before the devices are sold in Africa, because when the components of the devices are not optimally recycled this will provide a constant flow of waste

5.3.5 Conclusion

For the development of a circular business model, especially for technical materials, the aspects of the butterfly are useful. The different aspects, like maintain, reuse/redistribute, refurbish/remanufacture and recycling, are important for the development of a circular business model for screening and triage devices in Africa. These aspects will be used in this report.

5.4 Conclusion

In this chapter the different aspects that can contribute to the development of a circular business model are described. These aspects will be used for the development of a circular business model for the screening and triage devices. The aspects are divided in three sections, namely the concepts for a new way of doing business, the value creation aspects and the aspects of the butterfly. Each section consists of different types of aspects.

The concepts for a new way of doing business consists of five business concepts and, each concept consists of different types of aspects that can be interesting for the development of a circular business model. The five concepts are the classic business concept, the hybrid concept, the gap exploiter concept, the access concept and the performance concept. Each concept has a different kind of system which can be useful for the development of a circular business model.

The value creation aspects consist of four concepts, namely the power of the inner circle, power of circling longer, power of cascaded use and power of pure cycles. These four together are a solid base for a circular business model. These concepts include many aspects that can be useful for the development of a circular business model. The value creation concept focusses more on the cycles and system of the products or service manufacturing, delivery and maintenance. The aspects of the butterfly focusses on all the stages of the devices. Each stage of the device (broken, upgrade or end-of-life) has some aspects which can improve the circularity of that stage. There are four aspects, namely maintenance, reuse/redistribute, refurbish/remanufacture and recycling

of the technical materials. The key partners in this cycle are the materials/parts manufacturer, product manufacturer and the retail/service provider. For the development of a circular business model, especially for technical materials, those aspects of the butterfly are useful.

All these different kinds of aspects are combined in one model. This model gives (see figure 5.4.1) a clear overview of all the aspects that can contribute to the development of a circular business model for the screening and triage devices. The circular building blocks together show four aspects that have a big impact on all the building blocks and the way the circular business model will be designed. The four aspects create two opposites, namely a service based or a product based contract and the purchase or leasing of the screening and triage devices.

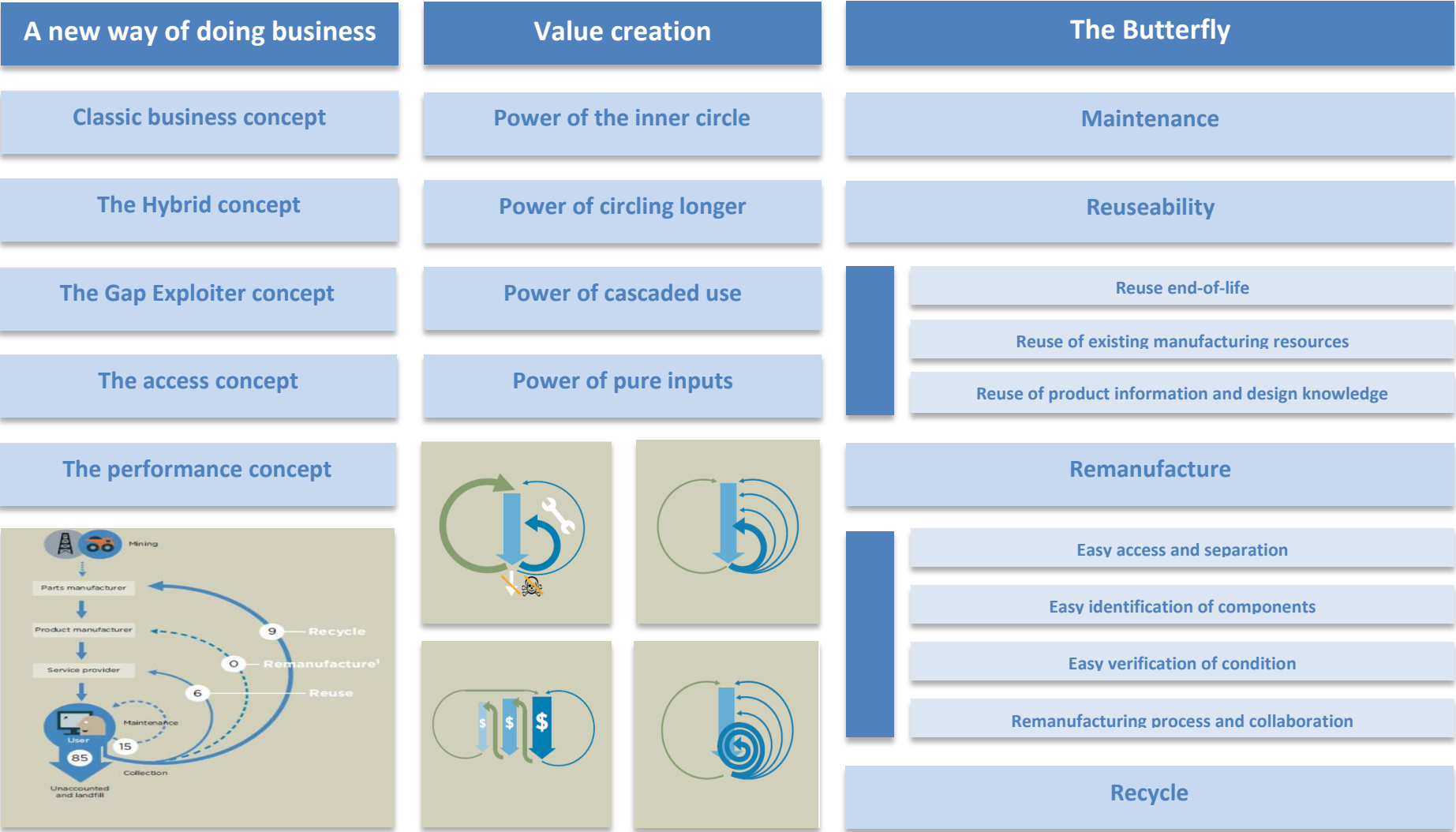
Service or product based

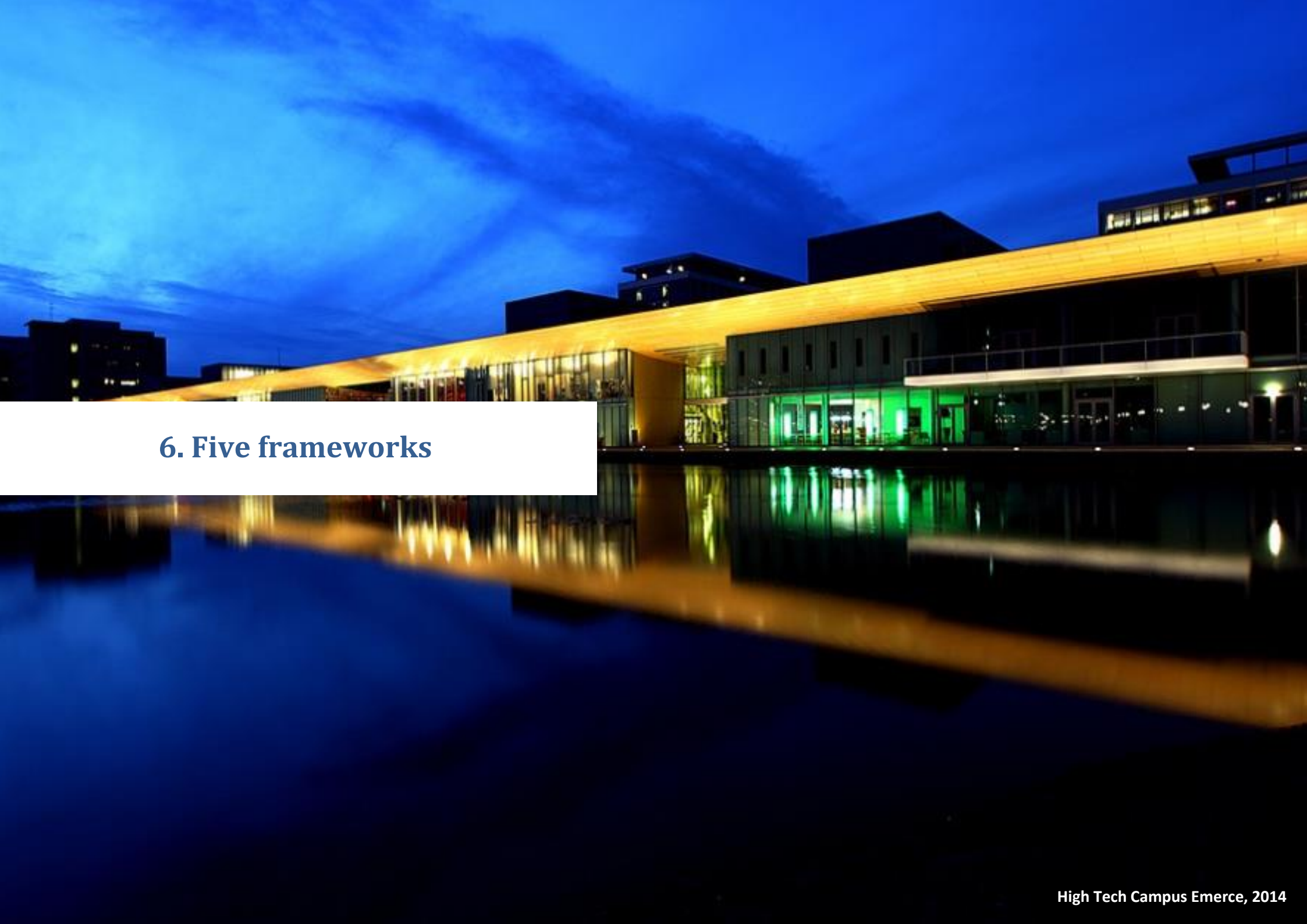
This aspect focusses on the after sales service of the devices, in this case there is a service provided by the manufacture/provider for the extension of the lifespan of the devices. A product based business model focusses on the selling of products, in this case there is no after-sales service provided by the manufacturer/provider. This has an impact on the lifespan of the devices.

Purchase or leasing

The purchase or leasing of the devices has an impact on the development of a circular business model. The difference of those two focusses on the responsibility for the maintenance and repair of the devices. When a customer purchases the device then it's the responsibility of the customer to maintain the device. For leasing the provider is responsible.

5.4.1 Building blocks for a circular business model overview





6. Five frameworks

The previous chapters contained many aspects and elements which are important for the development of a circular business model for screening and triage devices in Kenya. In chapter 3 the healthcare system in Africa, in specific Kenya, is described. This chapter provides a good overview of the market for the screening and triage devices, with focus on the primary health (health centers and nursing homes). There are three markets that can be interesting, the public sector (government), the growing private sector and the non-governmental organizations (NGO's).

In chapter 4 the need for a circular business model is described, in specific a circular business model for screening and triage devices in Kenya. In line with this are the building blocks of a circular business model, described in chapter 5. Those building blocks will be used for the development of the conceptual frameworks of the circular business models which are described in this chapter.

6.1 Business models

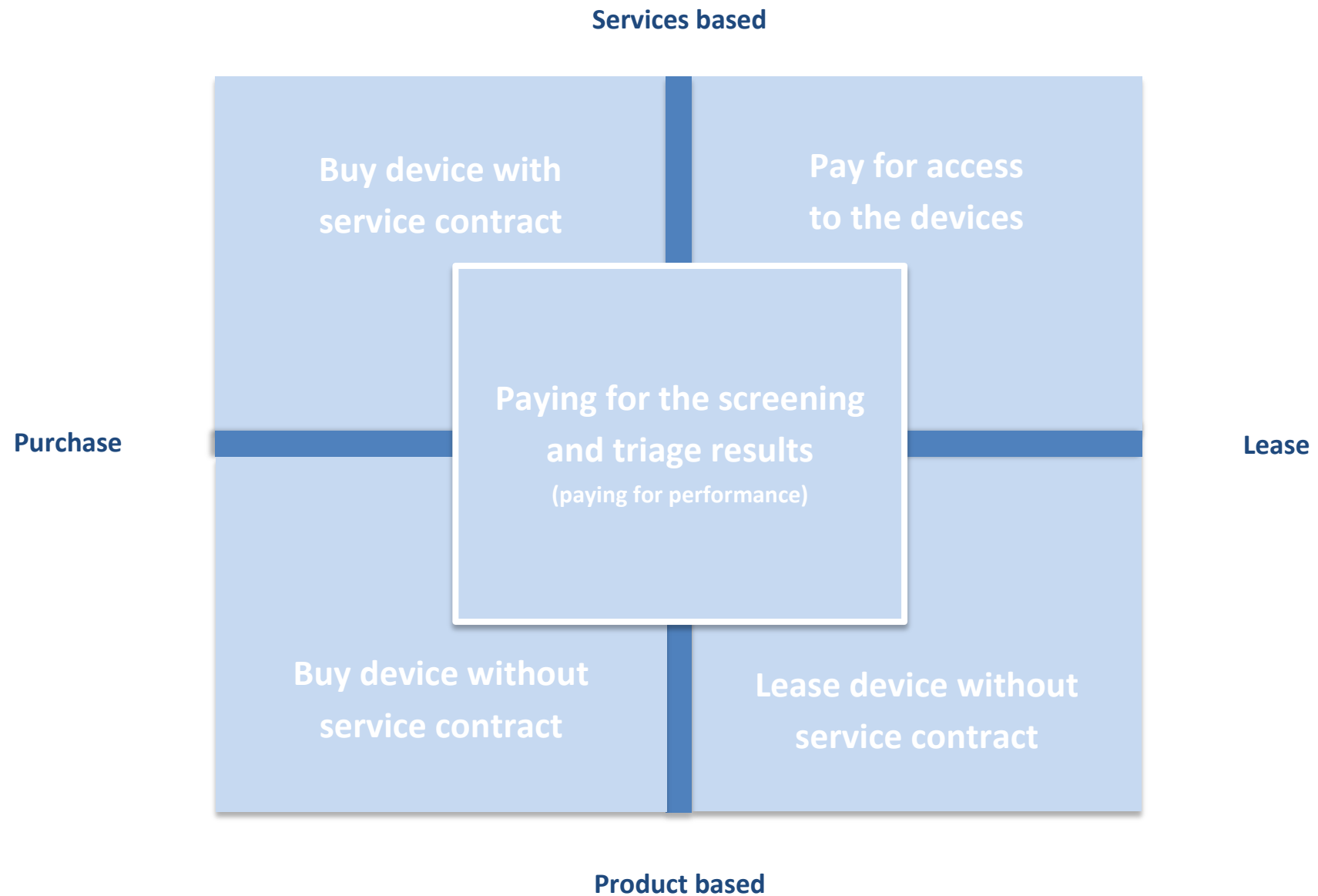
The different kind of building blocks, that are described in chapter 5, lead to two opposites, a service or product based contract and the purchase or leasing of the screening and triage devices. Service based contracts focusses on the after sales service of the devices. In this case there is a service provided by the manufacturer/provider for the extension of the lifespan of the devices. A product based business model focusses on the selling of products. In this case there is no after-sales service provided by the manufacture/provider. This has an impact on the lifespan of the devices.

The purchase or leasing of the devices has an impact on the development of a circular business model. The difference of those two is in on the responsibility for the maintenance and repair of the devices. When a customer purchases the device then it's the responsibility of the customer to maintenance the device. For leasing the provider is responsible for the maintenance and repair of the devices.

In this chapter the conclusions of the previous chapters are combined in five conceptual frameworks for the development of a circular business model for the screening and triage devices. The two opposites, service or product based and purchase or leasing, are used for the first criteria of the frameworks, because chapter 5 showed that those two opposites have a big impact on the total circular business model. The two opposites are used for the development of the different frameworks: see figure 6.1.1 'Five circular business model concepts'.

The two opposites (axes) lead to five frameworks of circular business models: buy device with service contract, buy device without service contract, pay for access to the devices, lease devices without service contract and paying for the screening and triage results. In this chapter those five models will be described more in detail. During a workshop with Philips employees the different frameworks were described. The results of the workshop are summarized for each framework. The different frameworks will be used for the development of the circular business model for the screening and triage devices.

Figure 6.1.1 Five circular business model concepts



6.2 Axes of the model

The model, see figure 6.1.1, that is used for the development of the five frameworks is based on the results of four aspects, namely service based, product based, an purchase and lease business model. These aspects are the result of the building blocks that are described in chapter 4. The four aspects are the basis for the five frameworks. All the five frameworks will refer to this model (figure 6.1.1).

In this part those four aspects will be described more in detail.

6.2.1 Service based

A service based business model focusses on the good maintenance and repair of the devices provided by the manufacturer or provider. In this case the consumer or user of the devices signs a services contract for the good after-sales services of the devices. In this case the manufacturer or provider is responsible for the good maintenance and repair of the devices. The good maintenance and repair is guaranteed during the lifespan of the devices. This has a positive effect on the circularity of a business model, because the good maintenance improves the lifespan of the devices and reduces the chance of broken devices, which has an impact on the flow of waste. A service contract can be interesting for Philips, because it provides a continuous financial flow and a good relationship with the customer in the long term.

The frameworks that are linked to the service based axes have a service contract with the manufacturer or provider. This service contract guarantees the good maintenance and repair of the devices.

6.2.2 Product based

A product based business model focusses on selling the devices from a manufacture (provider) to a customer. In this situation there is no after-sales service provided by the manufacturer or provider. The owner of the devices or user is responsible for the good use of the devices. In this case the manufacturer or provider can still have an impact on the good maintenance and repair of the devices, by providing clear instructions for the good use and repair of the devices. A close relationship with a gap exploiter can also help to improve the maintenance of the devices. It can be interesting for Philips to work closely together with a gap exploiter, because it provides a good reputation (help to repair locally). Philips can use the components for new devices and will get more control in the second hand market.

The frameworks that are linked to the product based axes focus on local repair. In this case the owner or user of the devices is responsible for the good use and maintenance of the devices.

6.2.3 Purchase

In the case of a business model where the devices are purchased (by the customer) the customer is the owner of the devices. The good maintenance and repair of the devices is in this case to the advantage of the owner of the devices, namely the customer. The extension of the lifespan of the devices will lead to an extension of the use of the devices. For the reputation of Philips it can be interesting to help the owner to maintenance and repair the devices to extend the lifespan of the devices.

The extension of the use of the devices leads to an increase of the patients that can be helped with the devices, which has a positive impact on the reputation of Philips. The purchase of the devices is 200 dollar (Bezemer, 2015).

The frameworks that are linked to the purchase axes focusses on the direct purchase of the devices by the customer. In this case the customer is the owner of the devices and therefore also interested in the good maintenance and repair of the devices.

6.2.4 Lease

In the case of a business model that focusses on the leasing of the devices, instead of selling them to the customers, the manufacturer or provider remains the owner of the devices. The good maintenance and repair of the devices is in this case to the advantage of the manufacturer or provider, because they are the owner of the devices. The good use and maintenance of the devices has a positive effect on the lifespan of the devices. The intension of the lifespan of the devices will also lead to an extension of the business that can be provided with the devices. The extension of the business will increase the revenues that can be provided with the devices. For Philips it can be interesting to lease the devices, which will lead to a good relationship with the customer or user, a long term financial flow and the ownership of the devices (control).

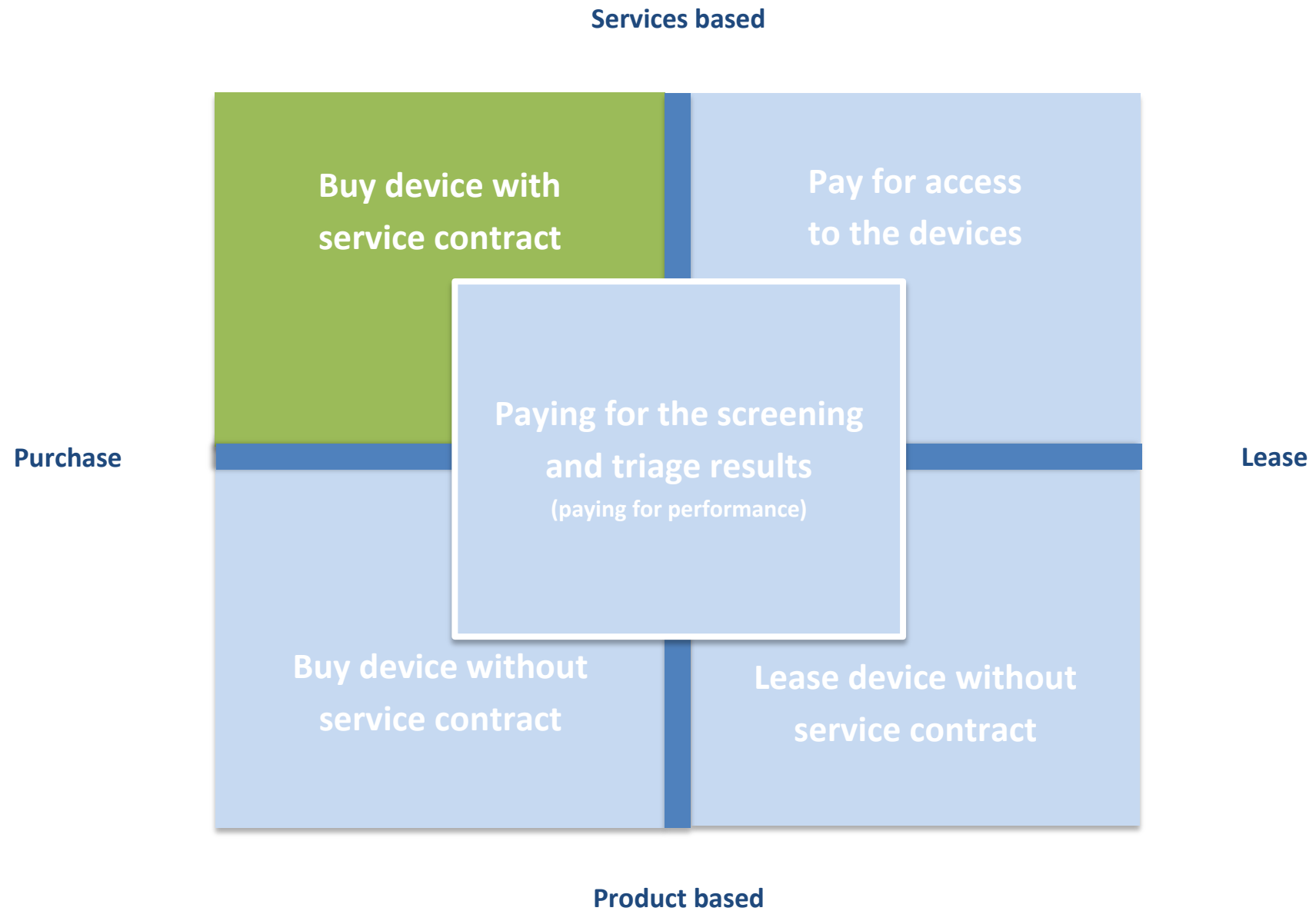
The frameworks that are linked to the leasing axes focusses on the leasing of the devices, instead of the purchase of the devices. In this case the manufacture or provider is the owner of the devices and therefore also interested in the good maintenance and repair of the devices.

6.3 Five frameworks

The previous described four aspects will be used in this part, the four axes lead to five frameworks. The five frameworks that will be described in this part are the buy device with service contract framework, the buy device without service contract framework, pay for access to the devices framework, lease devices without services contract framework and paying for the screening and triage results framework. Each framework is developed in a structured way.

The framework (business model concepts) starts with a clear introduction, then this introduction is summarized in a table with the positives and negatives of the framework. Those positives and negatives provided a clear overview of the differences of each framework. Secondly the framework is visualized, which provides a clear overview. Next to this visualization is also a summary with the different steps described.

Those aspects all have the same structure, which makes it possible to evaluate and compare the different frameworks. On the next page the first framework is described.



6.3.1 Buy device with service contract

In this business model concept, called concept 1, the user of the devices buys the devices from Philips with a service contract. The user is the owner of the devices and wants the service for maintenance and remanufacturing from Philips. In this case Philips is responsible for the continuity of the devices. When a device is broken Philips will replace it with a temporary device. After the repair of the older device Philips will exchange the older device for an temporary replacement device.

This business model concept focusses more on the Classic business concept, see 5.1.1. The lifespan of the device will extend by the continuity of maintenance provided by the Philips aftersales service (service contract). In this concept Philips works closely together with the owner of the product. This tighter cycle has an positive effect on the sustainable use of the product, as described in the power of the inner circle (5.2.1). Small defects of the devices can be repaired easily in a local Philips mobile maintenance bus, which makes the repair time shorter. More complex defects will be sent to the Philips Factory and, the owner will receive a temporary replacement device. This maintenance has a positive effect on the lifespan of the device and makes it possible to use the device longer, also described as the power of circling longer (5.2.2).

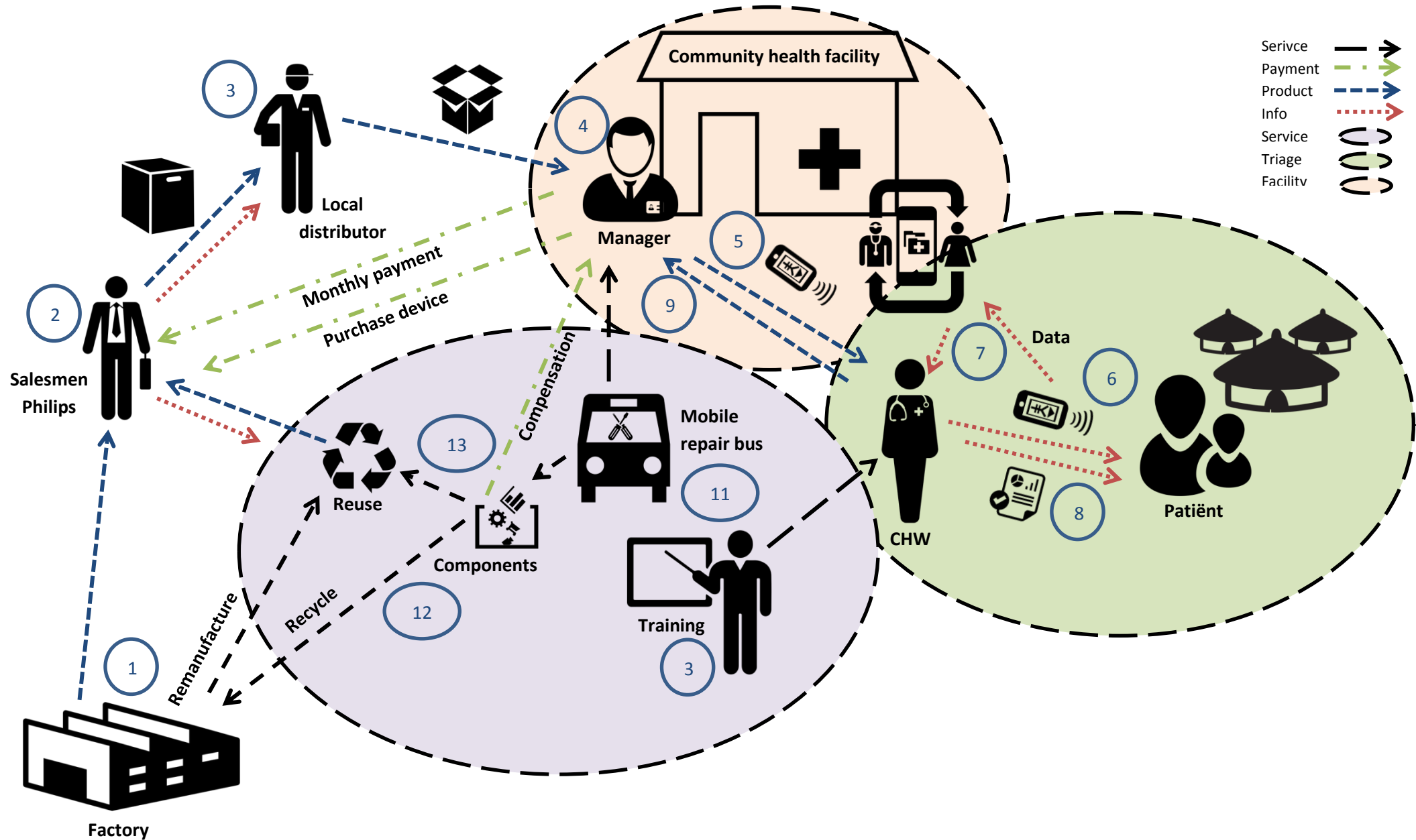
At the end of lifespan Philips will collect the old devices and reuses the components of the devices for the manufacturing of new devices. This cascaded use of the components has a positive effect on the circularity of the business model concept, see 5.2.3. The owner of the product will receive a small financial compensation for the collection of the old devices from Philips.

	Positives	Negatives
Owner device	- Is direct owner of the device. - Customer-focused aftersales service, which makes optimal use of the devices possible.	- Periodic payment for the aftersales service. - Must pay the entire price of the device at once.
CHW	- Can always use a good functioning device. - less responsibility, if a device breaks the consequences are less severe. (aftersales service)	Control by an additional stakeholder (Philips).
Patient	Is screened by good functioning devices.	The costs of the aftersales service can be charged to the patient.
Philips	Closer and durable relationship with the customer.	Cost of service can vary strongly.

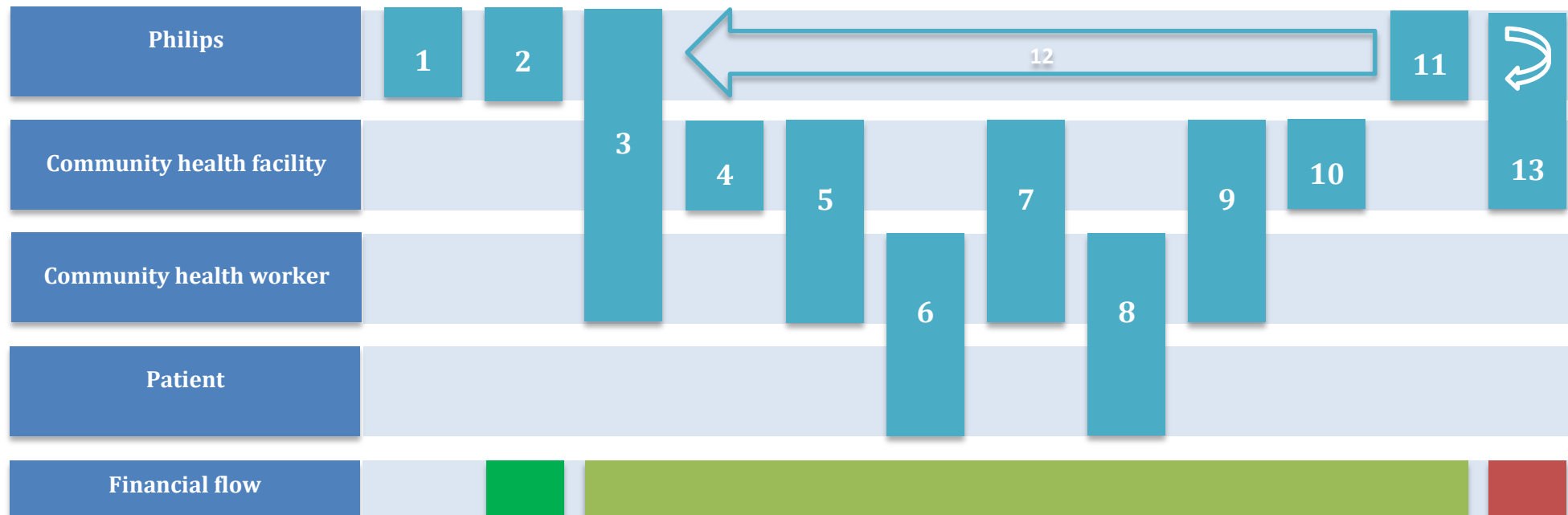
(source: brainstorm sessions and desk research)

Financial flow	Step	Indication
Purchase device (++)	2	200
Service contract (+)	2-13	?
Compensation (-)	13	(end-of-lifespan)
Total (after 1 year)	x	

Buy the device with service contract

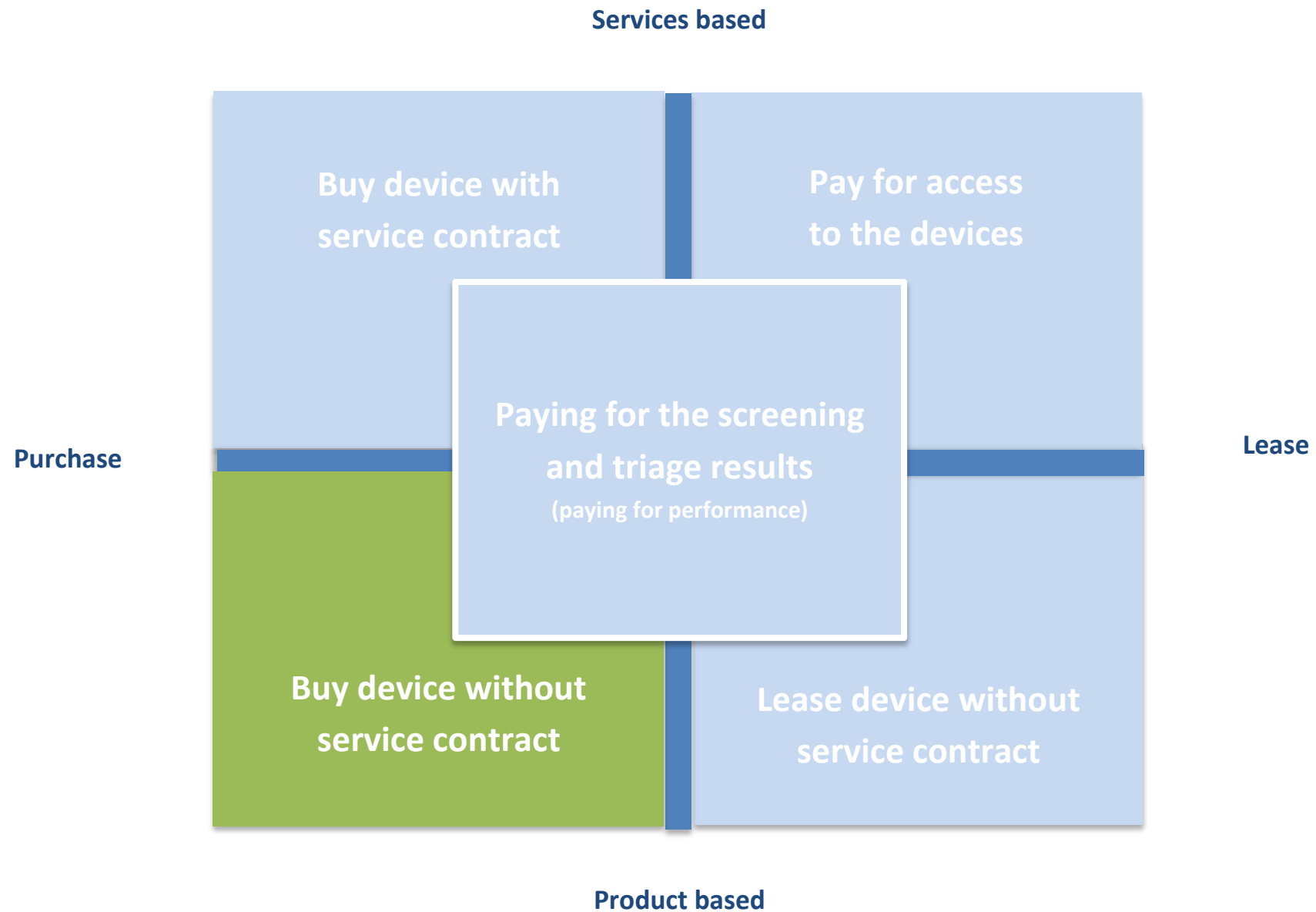


Visual overview circular business model (concept 1)



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- | | |
|---|---|
| <p>1) The design and production of the devices.</p> <p>2) The customer buys the devices from Philips, the customer is now the owner of the devices.</p> <p>3) The distribution of the devices to the customer and Philips facilitates training for the good use of the devices by the Community Health Worker.</p> <p>4) The owner (Community Health Facility) verifies the product and adds the devices to its healthcare system.</p> <p>5) The CHW (Community Health Worker) retrieves the devices at the Community Health Facility and goes to the patients in the more rural regions.</p> <p>6) The CHW uses the device for the screening and triage of the patients.</p> <p>7) The CHW sends the collected data (heart rate, blood pressure or long sounds) to the Community Health Facility for a diagnosis. The Community Health Facility sends a (digital) analysis report of the collected data back to the CHW.</p> <p>8) The treatment of the patient is dependent of this analysis.</p> | <p>9) The CHW brings the device back to the Community Health Facility, the facility verifies and registers the device.</p> <p>10) The Community Health Facility will check the device on possible defects. There are two options: the device is broken (go to 11) or, the device meets the requirements (go to 4)</p> <p>11) The Community Health Facility will contact the Philips aftersales service department. Philips will pick up the device and repair (maintenance) the device in a mobile maintenance bus, after repair Philips will deliver the device back to the Community Health Facility (4).</p> <p>12) More complex defects will be repaired in the factory, during the repair the Community Health Facility will receive a temporary replacement device.</p> <p>13) At the end-of-life time of the devices Philips will collect the components of the devices, which will be used for the manufacturing of new devices. The Community Health Facility will receive compensation.</p> |
|---|---|



6.3.2 Buy device without service contract

In this business model concept, called concept 2, the user of the devices buys the devices from Philips without a service contract. The user is the owner of the products and does not want the service for maintenance and repair from Philips. In this case Philips is not responsible for the continuity of the devices, so when a device is broken it is up to the owner to make the choice how to repair it.

The owner is responsible for the quality of the devices. The owner will not always choose for the good maintenance of the devices, because of the costs and the demand for the devices. During the repair the owner will not receive a temporary device, therefore fast repair of the devices is important. This means that the defective devices need to be repaired by a local repairer, which is also called a Gap exploiter (see 5.1.3). At the end-of-life time the Gap exploiter will collect the components of the devices and use them for the production of new products or sell it to Philips for the manufacturing of new devices. For Philips it is interesting to have a close relationship, also called power of the inner circle (5.2.1), with the Gap exploiter to stimulate the maintenance of the devices. This maintenance delivered by the Gap exploiter has a positive effect on the lifespan of the device and makes it possible to use the device longer, also described as the power of circling longer (5.2.2).

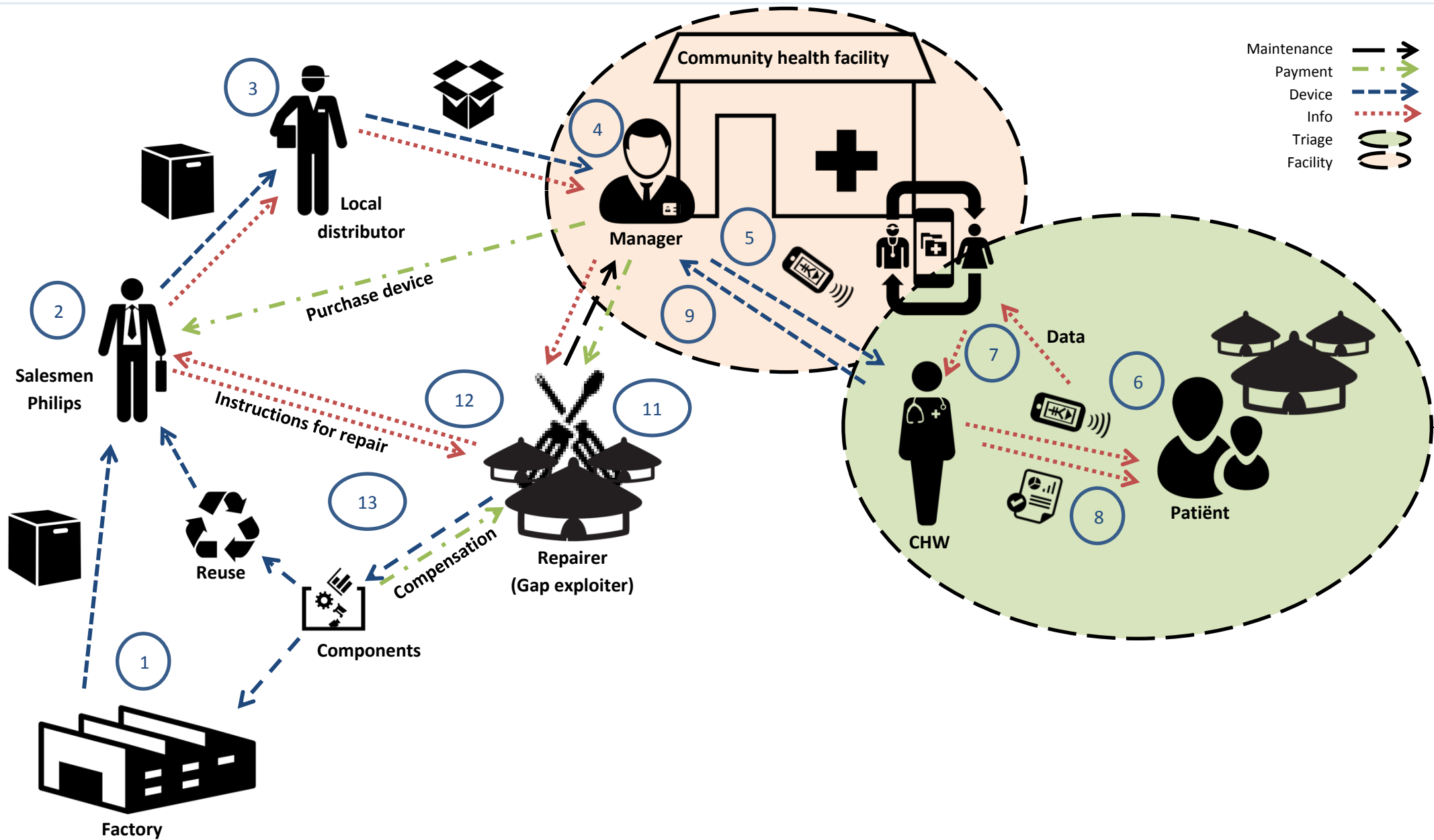
At the end of lifespan the Gap exploiter will collect the old devices, after which Philips will reuse components of the devices for the manufacturing of new devices. This cascaded use of the components has a positive effect on the circularity of the business model concept, see 5.2.3. The owner of the product will receive a small financial compensation for the collection of the old devices from the Gap exploiter.

	Positives	Negatives
Owner device	- Is directly the owner of the device. - No periodic payments.	- No aftersales service that improve the quality of the devices. - Pays the entire price of the device at once. - No temporary device during maintenance.
CHW	Not controlled by an additional stakeholder, like Philips.	- The devices are not working optimal, because they are not maintained periodically. - More responsibility for the good use of the devices.
Patient	There are no periodic costs that can be charged to the patient.	Is not always screened by good functioning devices.
Philips	Closer and durable relationship with the Gap Exploiter.	No close relationship with the owner of the devices (CHF).

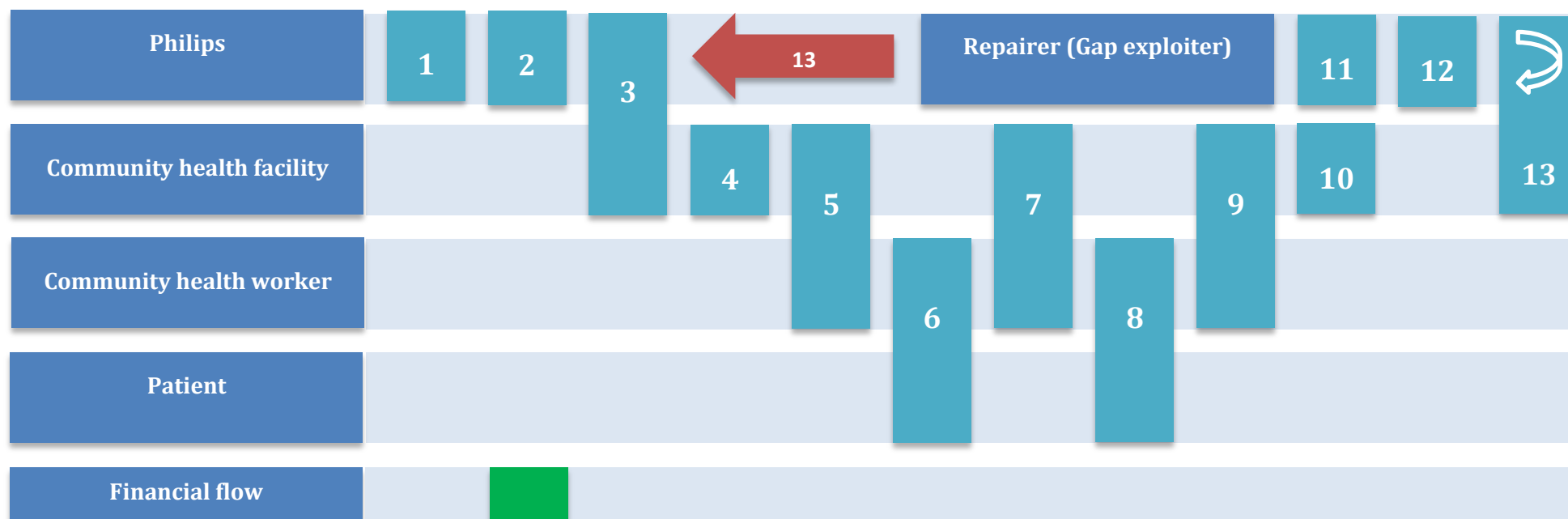
(source: brainstorm sessions and desk research)

Financial flow	Step	Indication
Purchase device (++)	2	200
Compensation (-)	13	(end-of-lifespan)
Total (after 1 year)	x	

Buy the device without service contract



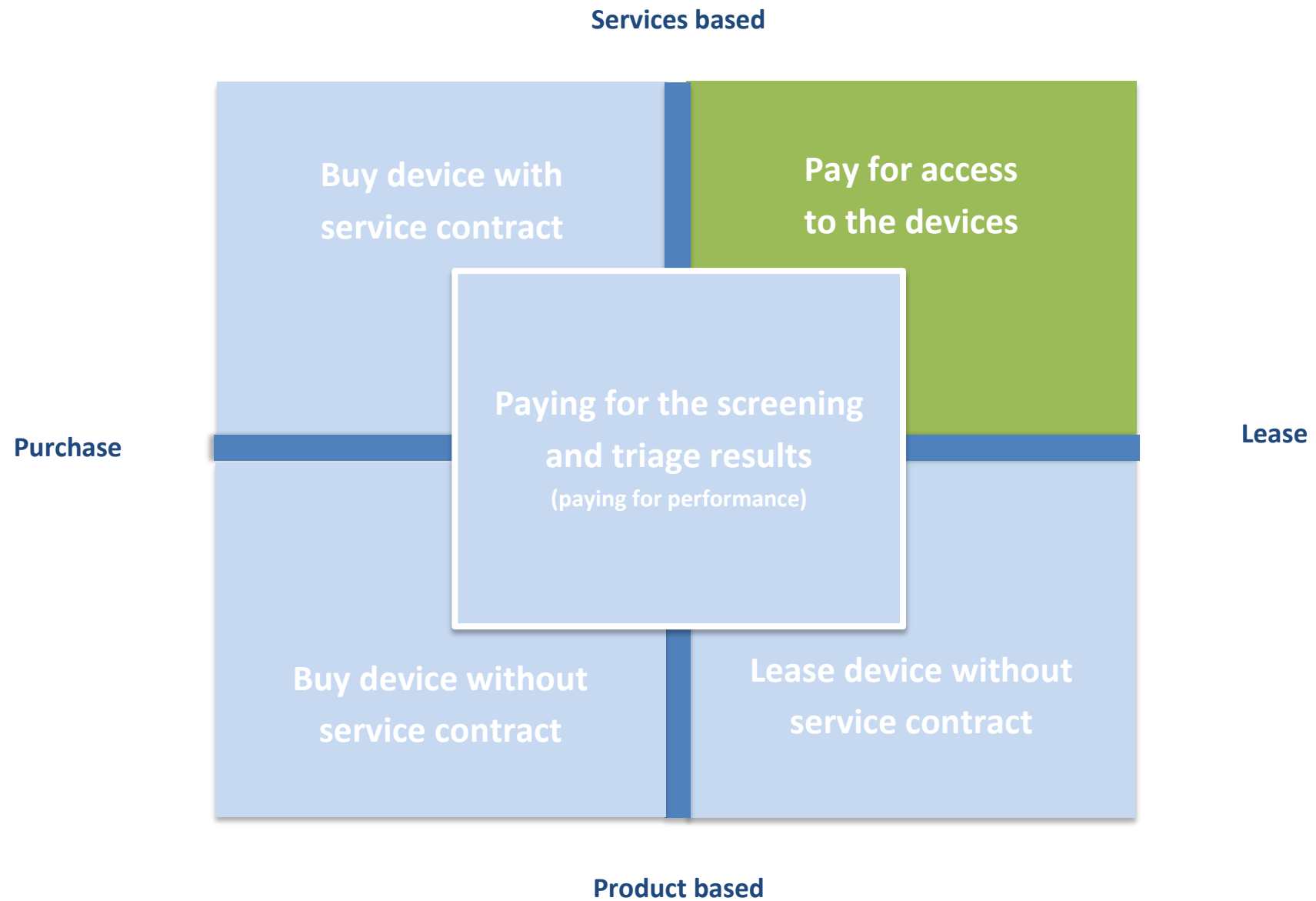
Visual overview circular business model (concept 2)



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- 1) The design and production of the devices.
- 2) The customer buys the devices from Philips: the customer is now the owner of the devices.
- 3) The distribution of the devices and instructions for good use and repair to the customer.
- 4) The owner (Community Health Facility) verifies the product and adds the devices to its healthcare system.
- 5) The CHW (Community Health Worker) retrieves the devices at the Community Health Facility and goes to the patients in the more rural regions.
- 6) The CHW uses the device for the screening and triage of the patients.
- 7) The CHW sends the collected data (heart rate, blood pressure or long sounds) to the Community Health Facility for a diagnosis. The Community Health Facility sends a (digital) analysis report of the collected data back to the CHW.
- 8) The treatment of the patient is dependent on this analysis.

- 9) The CHW brings the device back to the Community Health Facility and the facility verifies and registers the device.
- 10) The Community Health Facility will check the device on possible defects. There are two options; the device is broken (go to 11) or, the device meets the requirements (go to 4)
- 11) The Community Health Facility will contact the Gap exploiter. The Gap exploiter will pick up the device and repair (maintenance) the device. After repair the Gap exploiter will deliver the repaired device back to the Community Health Facility (4).
- 12) Philips will send the Gap exploiter some instructions for optimal repair and remanufacturing of components (these components will be sold to Philips).
- 13) At the end-of-life of the devices the Gap exploiter will buy the components from the owner and sell some components to Philips, which can be useful for the manufacturing of new devices.



6.3.3 Pay for access to the devices

In this business model concept, called concept 3, the user of the devices leases the devices from Philips with a service contract. Philips remains the owner of the products. In this case Philips is responsible for the continuity and updating of the devices, so when a device is broken or outdated (new software or hardware available) Philips will replace this device.

This business model concept focusses more on the access business concept, see 5.1.4. In this case the ownership of the devices is not important for the user, because it does not provide status or identity to the owner. More users can use one product, therefore more patients can be helped with a device and less devices are needed (circular aspect). The lifespan of the device will extend with the continuous maintenance provided by Philips (service contract). In this concept Philips works closely together with the user of the product. This tighter cycle has an positive effect on the sustainable use of the product, as described in the power of the inner circle (5.2.1). The development of technical devices can be fast, so many technical devices quickly become outdated. The user wants the latest versions of the devices, so in this business model Philips (provider) will lease the latest versions of the screening and triage devices to the user. The old devices will be used for another (cheaper) second-hand market and thereby also smaller markets will get access to the devices, the power of circling longer (5.2.2).

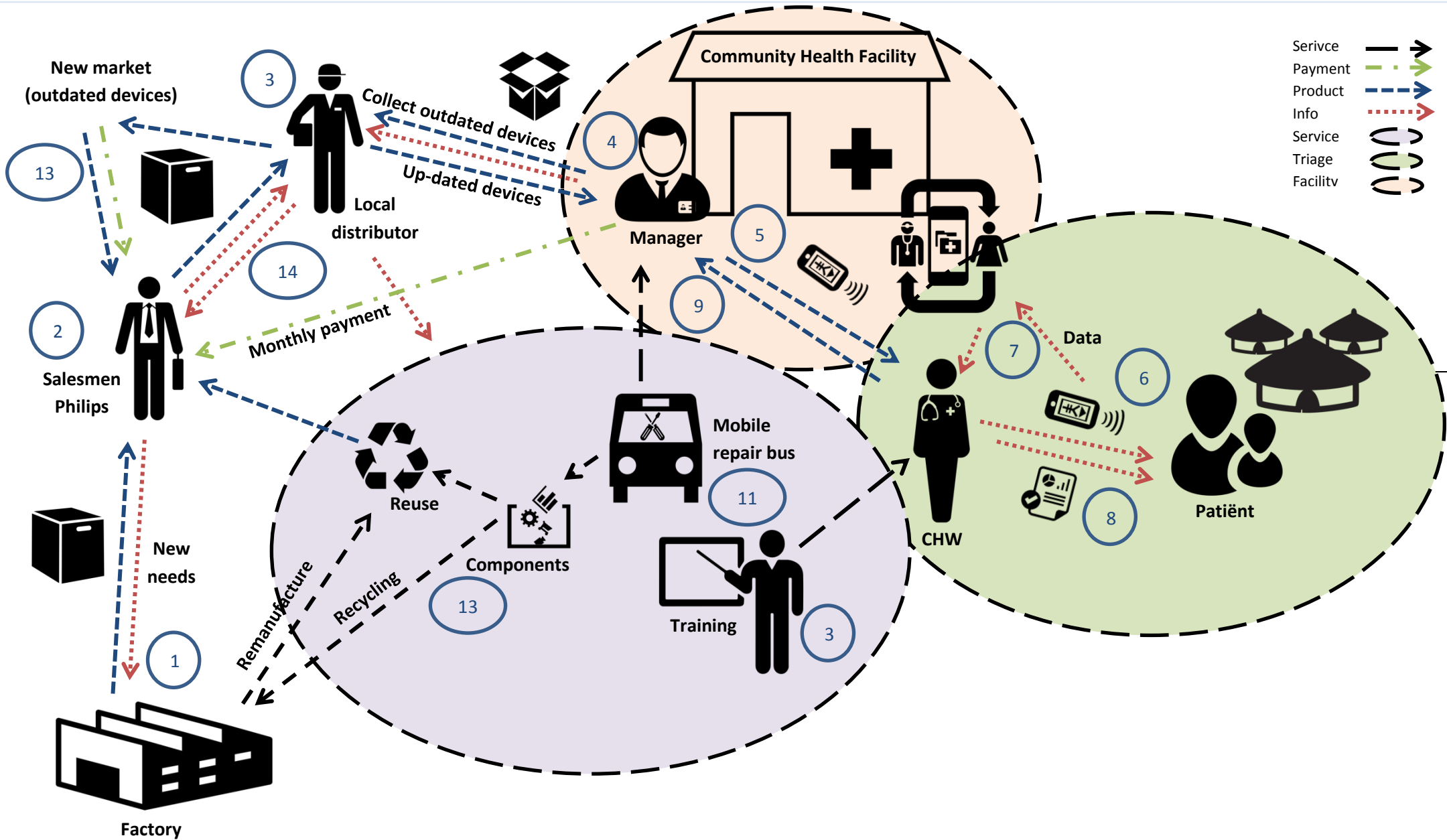
At the end of lifespan (second-hand market) Philips will collect the old devices and will reuse components of the devices for the manufacturing of new devices. This cascaded use of the components has a positive effect on the circularity of the business model concept (5.2.3).

	Positives	Negatives
Owner device	- Customer-focused maintenance service, which makes optimal use of the devices possible. - No need to pay a large amount in one time.	- Periodic payment for the leasing of the devices and maintenance service. - No ownership of the devices,
CHW	- Can always use a good functioning device. - Less responsibility: if a device breaks the consequences are less severe. (maintenance service)	Control by an additional stakeholder (Philips).
Patient	Is screened by good functioning devices.	The costs of leasing and service can be charged to the patient.
Philips	Closer and durable relationship with the customer.	Cost of service can vary strongly.

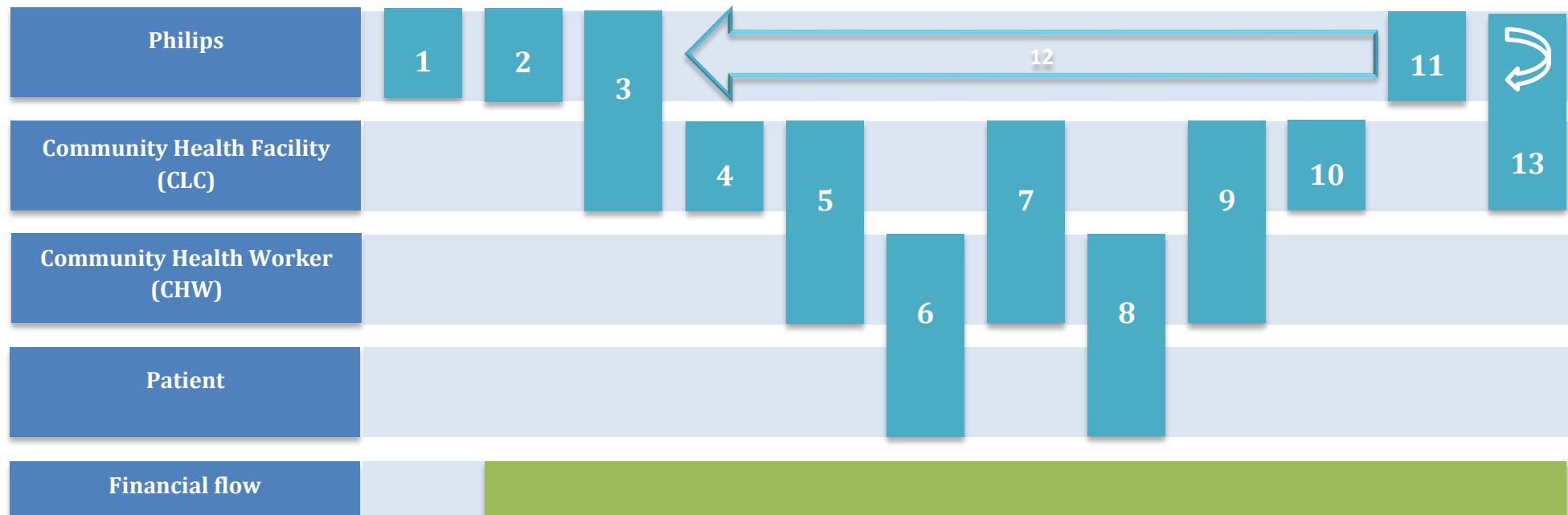
(source: brainstorm sessions and desk research)

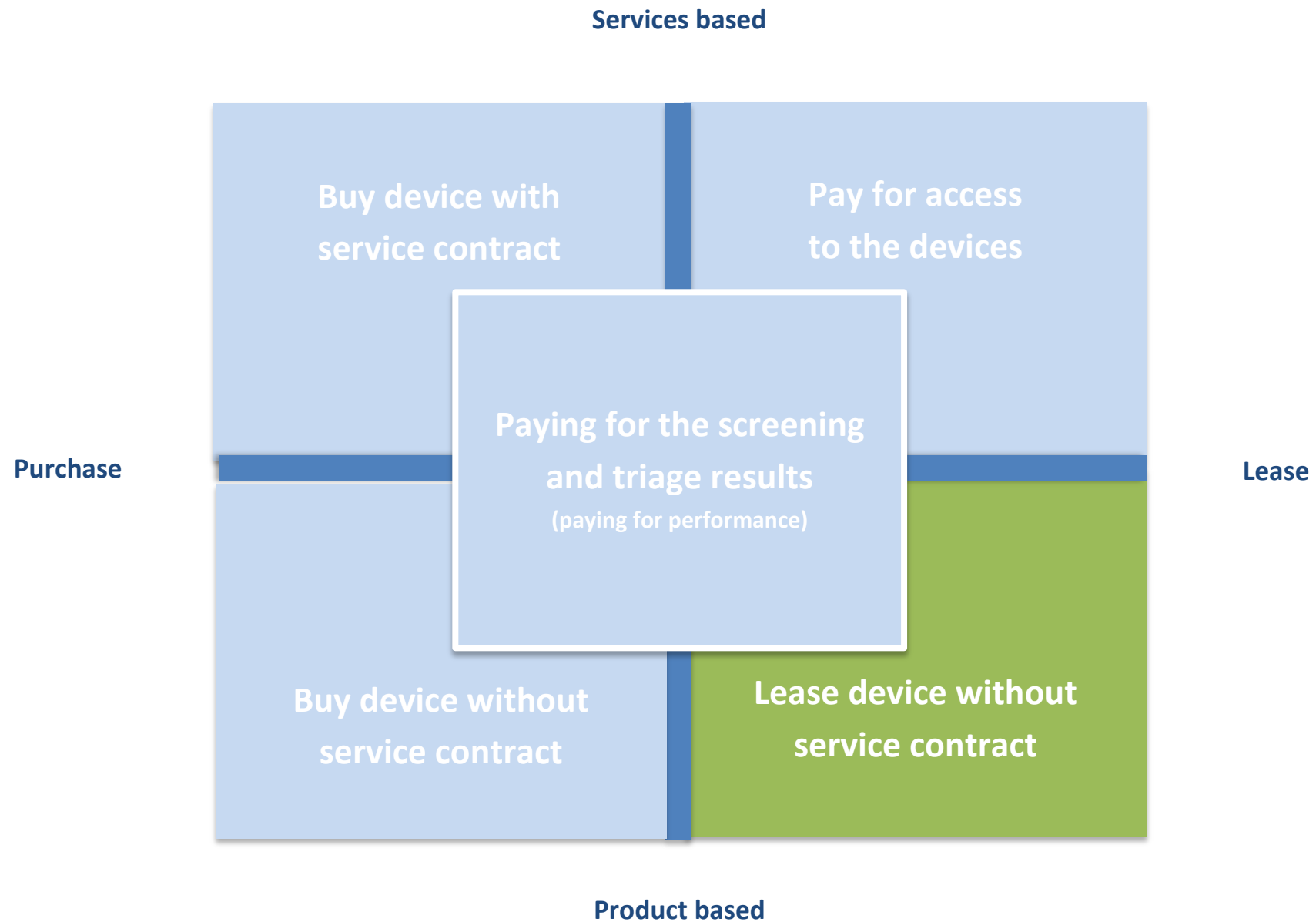
Financial flow	Step	Indication
Lease device (+)	2-13	?
Service contract (+)	2-13	?
Total (after 1 year)	x	

Pay for access to the devices



Visual overview circular business model (concept 3)





6.3.4 Lease device without service contract

In this business model concept, called concept 4, the user of the devices leases the devices from Philips without a service contract. Philips remains the owner of the products. In this case the user is responsible for the continuity of the devices. When a device is broken then it is the responsibility of the user to repair the device.

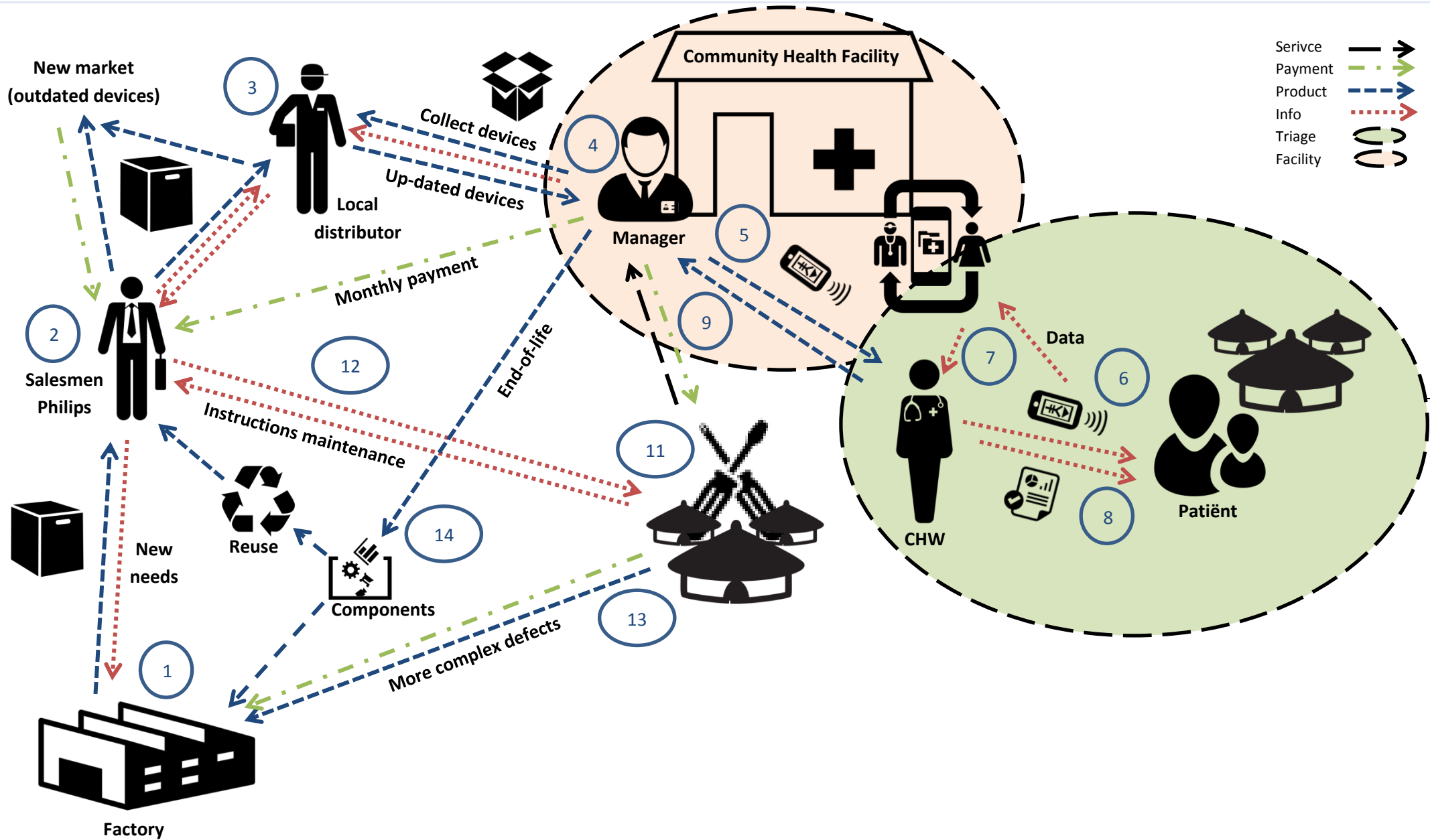
This business model concept focusses more on the access business concept, see 5.1.4. In this case the ownership of the devices is not important for the user, because it does not provide status or identity to the owner. More users can use one product (lease/shared use), therefore more patients can be helped with a device. The user is responsible for the quality of the devices. The user will not always choose for the good maintenance of the devices, because of the costs and the demand for the devices. The repair of the devices is also the responsibility of the owner. During the repair the owner will not receive a temporary device: therefore the fast repair of the devices is important. This means that the defective devices need to be repaired by a local repairer, which is also called a Gap exploiter (see 5.1.3). For Philips it is interesting to have a close relationship, power of the inner circle (5.2.1), with the Gap exploiter to stimulate the maintenance of the products. This maintenance delivered by the Gap exploiter has a positive effect on the lifespan of the device and makes it possible to use the device longer, also described as the power of circling longer (5.2.2).

At the end of lifespan will Philips collect the old devices, and will reuse components of the devices for the manufacturing of new devices. This cascaded use of the components has a positive effect on the circularity of the business model concept (5.2.3).

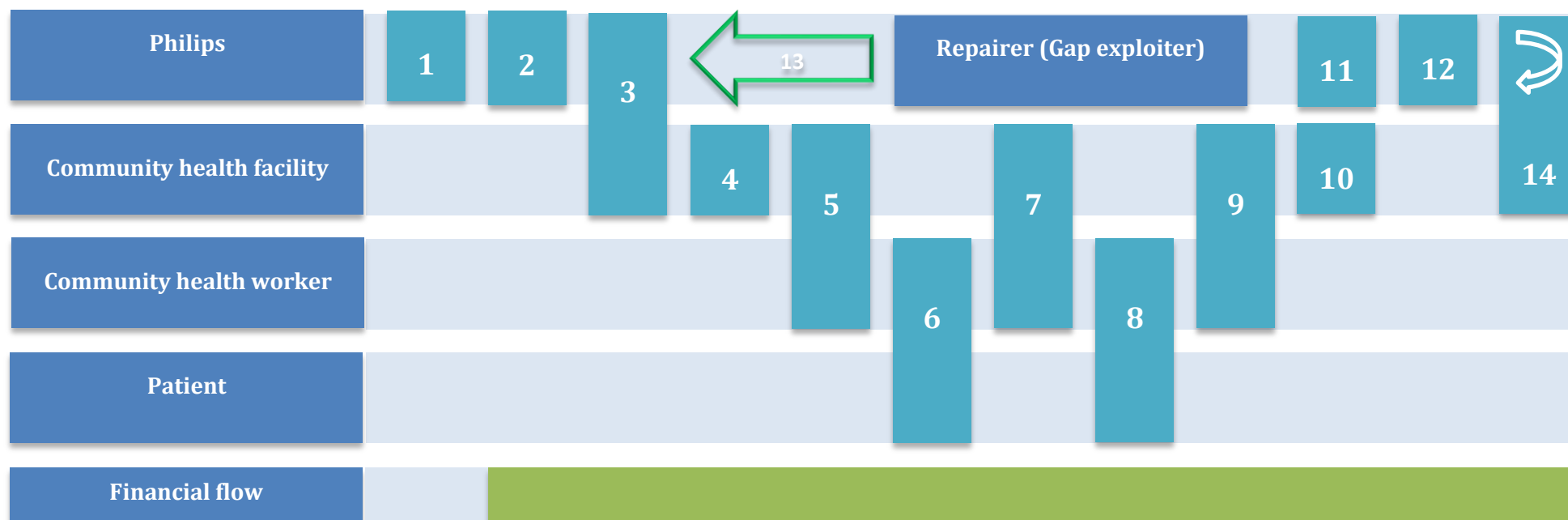
	Positives	Negatives
Owner device	- No need to pay a large amount in one time. - Latest devices (updated)	- Periodic payment for the leasing of the devices. - No ownership of the devices,
CHW	- Not controlled by an additional stakeholder, like Philips. - Can use the latest devices (updated)	- The devices are not working optimally. because they are not maintained periodically. - More responsibility for the good use of the devices.
Patient	More patients can be helped with one device, because of the shared use.	The costs of leasing can be charged to the patient.
Philips	Closer and durable relationship with the user and Gap exploiter.	Devices can be stolen.

(source: brainstorm sessions and desk research)

Financial flow	Step	Indication
Lease device (+)	2-14	?
Total (after 1 year)	x	

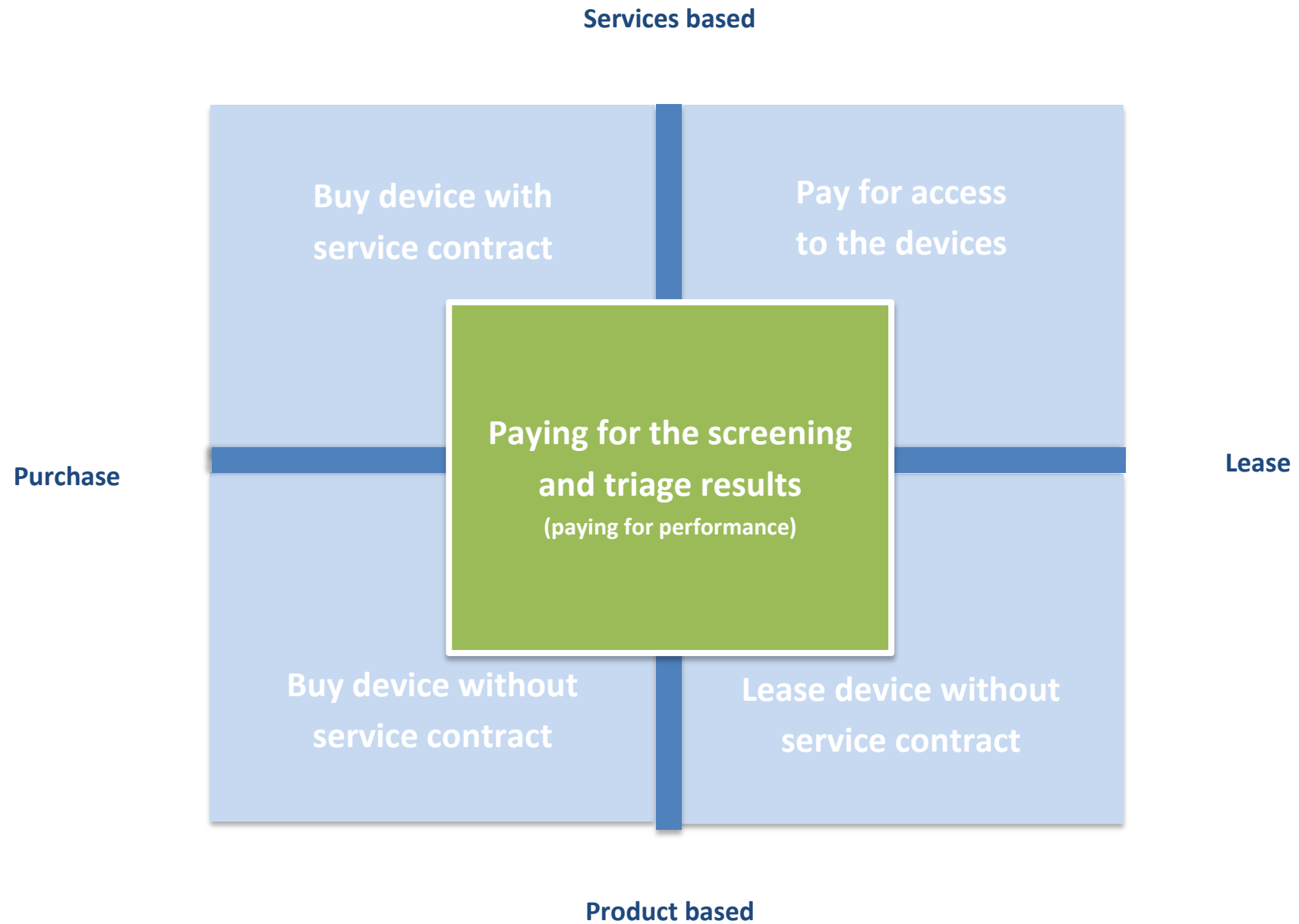


Visual overview circular business model (concept 4)



62

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| 1) The design and production of the devices. | 10) The Community Health Facility will check the device on possible defects, there are two options; the device is broken (go to 11) or outdated (go to 3) or, the device meets the requirements (go to 4). |
| 2) Philips will lease the device to the user, but remains the owner of the device. | 11) The Community Health Facility will contact the Gap exploiter, the Gap exploiter will pick up the device and repair (maintenance) the device. |
| 3) The distribution of the devices to the user and the collection of outdated devices, these devices will be distributed to second-hand markets. | 12) Philips will send the Gap exploiter some instructions for optimal repair and remanufacturing of components (these components will be sold to Philips). |
| 4) The user (Community Health Facility) verifies the product and adds the devices to its healthcare system. | 13) More complex defects will be repaired in the Philips factory, the user receives a new (lease) device, the user must pay for this service. |
| 5) The CHW (Community Health Worker) retrieves the devices at the Community Health Facility and goes to the patients in the more rural regions. | 14) At the end-of-life time or end of contract Philips will collect the devices from the users. Philips will use the components of the devices for the manufacturing of new devices. |
| 6) The CHW uses the device for the screening and triage of the patients. | 15) The representative of Philips will maintain a good relationship with the users (needs), second-hand market (demand) and the factory (new innovations). |
| 7) The CHW sends the collected data (heart rate, blood pressure or long sounds) to the Community Health Facility for a diagnosis. The Community Health Facility sends a (digital) analysis report of the collected data back to the CHW. | |
| 8) The treatment of the patient is dependent on this analysis. | |
| 9) The CHW brings the device back to the Community Health Facility. | |



6.3.5 Paying for the screening and triage results (performance)

In this business model concept, called concept 5, the community health facility is not interested in the devices that deliver the results. The Community Health Facility is only interested in the results of the devices and therefore only wants to pay for these results. This is also called paying for performance (5.1.5): paying for the service of the devices. The Community Health Facility will periodically pay Philips for the healthcare service (provided by the healthcare devices).

During the service remains Philips the owner of the devices. The devices will be under control of a local Philips manager, who is responsible for the continuity of the devices. When a device is broken the manager will contact a Philips employee to replace the device. In this model Philips is responsible for the entire service provided by the devices. Therefore the cycle of maintenance and stakeholders is smaller, which leads to the power of the inner circle (5.2.1). This overarching ownership makes the extension of the lifespan of the devices more interesting, because an extended lifespan also leads to an extension of the (business) service delivered with the device. In this concept Philips works closely together with the Community Health Worker. This tighter cycle has a positive effect on the sustainable use of the product, as described in the power of the inner circle (5.2.1).

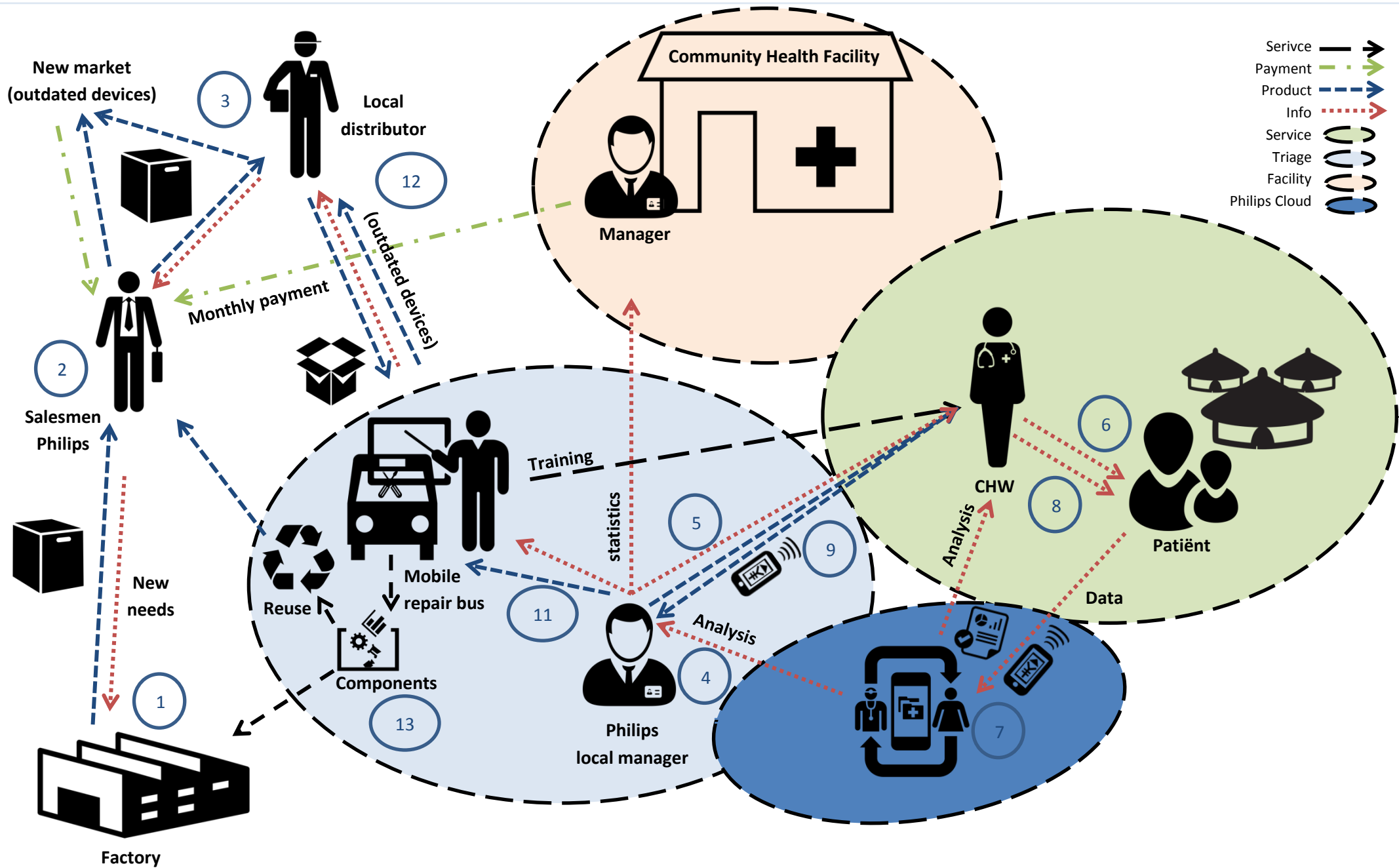
The collected (screening and triage) data will be sent to the Philips cloud. In this Philips cloud the data will be analyzed and sent back to the CHW. The data will also be stored there, which reduces the paper based patients dossiers in the Community Health Center. At the end of lifespan will Philips collect the old devices, and will reuse components of the devices for the manufacturing of new devices, which is also called the cascaded (5.2.3) use of the components.

	Positives	Negatives
Owner device	- Easier process - Digital overview - Not responsible for the devices.	Periodic payment for the service.
CHW	- Can always use a good functioning device. - less responsibility, if a device breaks are the consequences less severe. (part of the service)	Control by an additional stakeholder (Philips).
Patient	Is screened by good functioning devices.	The costs of the aftersales service can be calculated to the patient.
Philips	- Closer and durable relationship with the customer. - Constant financial flow.	Cost of service can vary strongly.

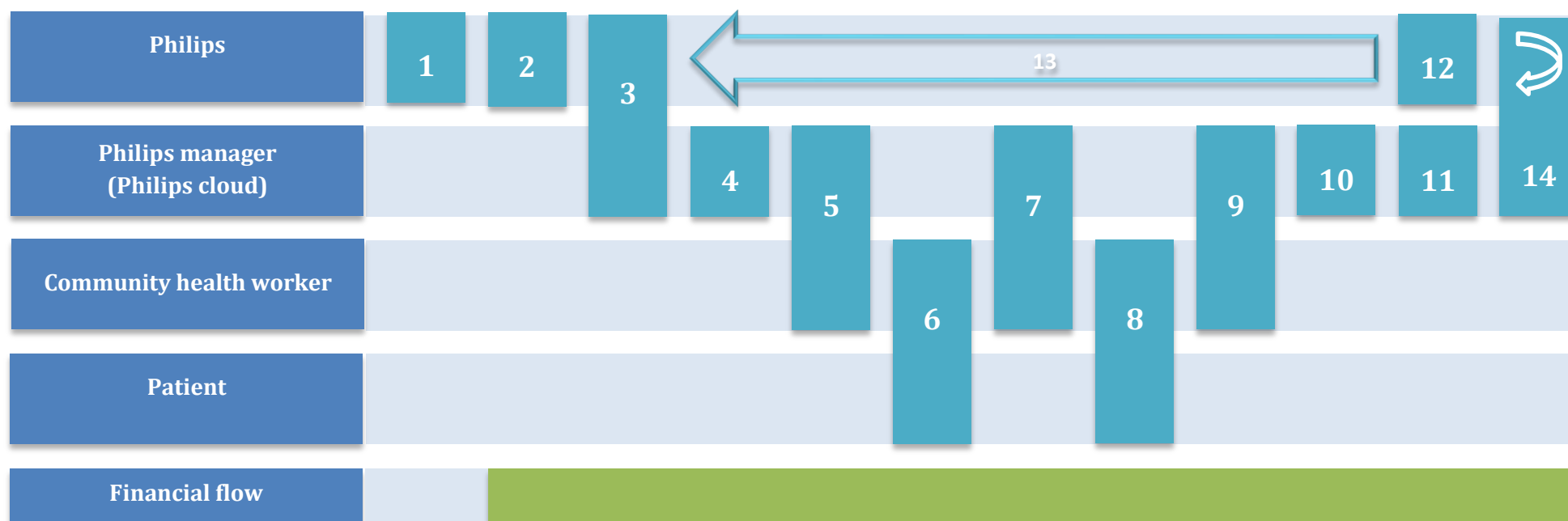
(source: brainstorm sessions and desk research)

Financial flow	Step	Indication
Paying for service (+)	2-14	?
Total (after 1 year)	x	

Paying for performance



Visual overview circular business model (concept 5)



66

- | | |
|---|--|
| <p>1) The design and production of the devices.</p> <p>2) The user pays for the service provided by Philips, Philips remains the owner of the devices.</p> <p>3) The distribution of the devices to the Philips manager and the manager facilitate a training for the good use of the devices by the CHW.</p> <p>4) The Philips manager will verify the product and add the devices to its health care system.</p> <p>5) The CHW (Community Health Worker) retrieves the devices by the Philips manager and goes to the patients in the more rural regions.</p> <p>6) The CHW uses the device for the screening and triage of the patients.</p> <p>7) The CHW sends the collected data (heart rate, blood pressure or long sounds) to the Philips cloud for a diagnosis. The Philips cloud send an (digital) analysis report of the collected data back to the CHW and Community Health Facility.</p> <p>8) The treatment of the patient is dependent of this analysis.</p> | <p>9) The CHW brings the device back to the Philips manager, he will verify and register the device.</p> <p>10) The Philips manager will check the device on possible defects, there are two options; the device is broken (go to 11) or outdated (go to 12) or, the device meets the requirements (go to 4).</p> <p>11) The Philips manager will contact the maintenance service department. An Philips employee will pick up the device and repair (maintenance) the device, during the repair will the Philips manager receive a (new) replacement device (4), so he can continue to provide healthcare service.</p> <p>12) Outdated devices will be sold at a cheaper second-hand market.</p> <p>13) At the end-of-life time or end of contract Philips will use the components of the devices for the manufacturing of new devices.</p> <p>14) The representative of Philips will maintain a good relationship with the users (needs), second-hand market (demand) and the factory (new innovations).</p> |
|---|--|

6.4 Workshop Eindhoven

The five frameworks of business models which are described in chapter 6.3 give a clear overview of the many options for the development of a circular business model for the screening and triage devices. Each framework has different kind of stakeholders, processes, positives and negatives. These differences are discussed during an workshop with six internal (Philips) experts.

During the workshop I divided the group into two smaller groups. Each group evaluated a circular business model for 15 minutes and then went to the next circular business model. until all the (five) business models were evaluated by all the groups. The objective of the workshop was to develop a clear list with positives, negatives and ideas for each circular business model. These results will be used for the development of the final circular business model.

In this part the results of the workshop are shown in clear tables (table 6.4.1 till table 6.4.3) which provide an overview of the many positives, negatives and ideas that emerged during the workshop. At the end of the workshop the two groups presented their results and ideas. The workshop closed with an overall conclusion which consisted of a few points that can be very interesting for the circular business model: education provided by NGO's (Flying doctors) or the church, long-term relationship with stakeholders (long-term contracts), the collection of patient data (selling to the government), educated local repairers, the theft of the devices (providing a sustainable business for Community Health Workers) and decision support (online doctors). Those few points are included in the conclusion of this part.



6.4.1 Positives

Definition	Mentioned by	Circular business model concept (framework)
Easy for Philips to implement.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1
Sustainable model; remanufacturing, recycling and reuse are included in the business model.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,2,3,4,5
The monthly payment makes it possible for Philips to build a long-term relationship with the customer (user).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,3,4,5
Service contracts, our competitive advantage.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,3,5
The service contracts ensure that Philips remain involved throughout the lifespan, this makes it possible for Philips to monitor and analyze the performance of the devices.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,3,5
Local repair is a better alternative than a service bus.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	2,4
Try to prevent broken products to stay there without use.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	3,5
Several control points throughout the use cycle. (maintenance, data, base, training etc.).	Robin van Dalen, Luc Geurts and Kevin Shahbazi	3,4,5
Leasing provides a steady cash flow/low-threshold.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,4
Repair (more local) and refurbish (more central).	Robin van Dalen, Luc Geurts and Kevin Shahbazi	2,4
Future of Philips; we sell services, no goods/boxes. Philips health data center/cloud is where we want to move into!	Robin van Dalen, Luc Geurts and Kevin Shahbazi	5
The collected patient data can provide a new financial flow for Philips, Philips can sell the data to the government and facilities.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	5

6.4.2 Negatives

Definition	Mentioned by	Circular business model concept (framework)
Theft of the devices (especially a problem for leasing the devices).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,2,3,4,5
What is the mindset on services, what kind of level of service?	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,5
Will mobile repair bus suit context (road conditions etc.)?	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,5
Does it make sense to pay monthly for service of device if it doesn't break that often and if it's a new product?	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,5
Large initial investment for clinic.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,2
Value leakage, why should gap exploiters sell components to use?	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	2,4
It costs us to help them (Gap exploiter and customer) keep the product in a closed-coon, why would we do it?	Robin van Dalen, Luc Geurts and Kevin Shahbazi	2,4
Quality of Philips product use depends on customers data management system.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,4,5
Will the server of a facility be safe? When data is collected through Philips product people expect Philips to take care of safe transfer.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	3,4,5
People might feel less responsible for device.	Rick Bezemer and Janne van Kollenburg	3,4,5
Manager will never be able to transfer education to the Community Health Worker.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	2,4
Income depends on the use by the Community Health Workers (will use the device less).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	5
It's not possible for Philips to do the analysis, decision support (because it can have an impact on the company name).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	5

6.4.3 Ideas

Definition	Mentioned by	Circular business model concept (framework)
You can include two hours of time from our repair guy (per month) in initial price.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,5
Repair (mobile) community. Community Health Worker she is mobile, get repair in community.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,2,3,4,5
Mobile health empowerment bus, include training, repair and roadshow/marketing.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,5
Rural regions, video Skype. Coach and code for the local repairer, makes it possible to repair the devices.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,4,5
Create incentive for Community Health Worker taking proper care of device (Clinic credit towards trade-in).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,3,5
GPS tracking 'find-my-device'.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,2,3,4,5
New business model: private community health workers. Ownership by the community health workers, less theft incentive.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,2,3,4,5
Facilitate repair; manual, remote service, modular design (as alternative for mobile bus).	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,5
Monetize data sending back (micro payment).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,3,5
Design for repair.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,2,3,4,5
Pay per use of maintenance.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,3,5
Share the devices (lease) between Community Health Workers or Community Health Facilities	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,4,5
Track the device flow, how often are the devices used. This gives Philips more insights.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,4,5

Better identification of patients would allow for data to be more trustworthy (less fraud).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,5
Sell healthcare empowerment, not devices (service).	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,4,5
Mobile health bus (see first business model for the idea), a good alternative can be to swap the devices for a working one and repair the broken one off-site.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,3,5
For the maintenance of the leased Philips devices qualified people are needed.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,4,5
NGO (Flying doctors) and churches can have an important role for the training and education of Community Health Workers.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,2,3,4,5
Prevent repair actions by non-Philips-qualified engineers (open-it, disable-it)	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	3,4,5
Online training for local repairer and Community Health Workers.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	2,4
Make the patient data valuable and useful.	Rick Bezemer, Simona Rocchi and Janne van Kollenburg	1,2,3,4,5
Can the service of the devices be free? Think about Google docs, Google search, all free users for maps.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	3,4,5
Philips owns the data (top-down) and can sell the patient data (for example to the government, epidemic management policy creation).	Robin van Dalen, Luc Geurts and Kevin Shahbazi	3,4,5
Health empowerment bus; training, trouble shooting and health advice.	Robin van Dalen, Luc Geurts and Kevin Shahbazi	1,2,3,4,5

6.4.4 Hypothesis

Distribution

- Philips can use local distributors for the distribution of the health measurement devices.
- Health facilities are willing to share and use health measurement devices from another facility.

Payment

- Monthly payment makes it possible for Philips to build a long-term relationship with the customer.
- Monthly payment is preferred by the local health facilities.
- It is preferred by the local customers to pay-per-use (access to the devices) instead of purchasing the devices.
- The private health sector can be an interesting market for the introduction of new devices.

Service

- Customer-focused aftersales service can be to Philips a competitive advantage.
- A training provided by NGO's can extend the lifespan of the devices (good use of the devices).
- GPS tracking 'find-my-device' can reduce the theft of the screening and triage devices.

Repair

- The broken devices can be repaired by local repairers.
- Local distributor can collect and distribute the broken devices.
- Online/mobile repair assistant can improve the opportunities for local repair.
- Easy disassembling of the health measurement devices can improve the opportunities for repair.
- Coding of the components of the health measurements devices can improve the opportunities for repair.
- For the maintenance of the Philips devices qualified people are needed.

Recycling

- Defective devices (end-of-lifespan) can be recycled locally.
- Easy disassembling of the health measurement devices can improve the opportunities for recycling.
- Instructions for how to disassemble (recycle) the devices can improve the opportunities for how to recycle the defective devices.

Data management

- The collected patient data can provide a new financial flow for Philips, Philips can sell the data to the government and the community health facilities.
- In Kenya there is a big need for patient and measurement data, the smart screening and triage devices should make it possible to collect this data.
- The health facilities can transfer the collected data to each other, which can improve the workflow efficiency.
- The health facilities can transfer the collected data to each other, which improves the quality of healthcare.
- It's not possible for Philips to do the analysis/decision support (because it can have an impact on the company name).
- Philips can use the data for tracking the device flow, which can help to improve the devices.
- The health workers are willing to send the collected patient and/or measurement data to Philips.

Motivating patients

- The church can play an important role in informing and motivating patients to go for a health check in/by a health facility.
- NGO's can play an important role in informing and motivating patients to go for a health check in/by a health facility.

6.5 Conclusion

In this chapter five possible frameworks for the development of circular business models are described. The frameworks are divided over two axes, namely with or without service contract, and purchase of the devices or leasing of the devices. There is no ideal framework for the development of the final circular business model, because each framework has some elements which can be useful for the development of the circular business model for the screening and triage devices.

During the workshop we concluded that the bases of the five circular business models are the same, but each circular business model has a few clear distinctions (same as the axes): with(or without) after sales service, purchase or leasing of the health measurement devices and the use of a Philips cloud for the collection of the data. The differences were evaluated during a workshop, and the results of the workshop (see 6.4 workshop Eindhoven) will be used for the development of the final circular business model (advice).

The workshop gave new insights about the positives and negatives of the five business model frameworks, but also gave a lot of new ideas on what the circular business model for screening and triage devices can look like. The workshop ended with an overall conclusion. This conclusion contained a few main important elements for the development of a circular business model for the screening and triage devices, namely education provided by NGO's (Flying doctors) or the church, long-term relationship with stakeholders (long-term contracts), the collection of patient data (selling to the government), education for local repairers, the theft of the devices (providing a sustainable business for community health workers) and decision support (online doctors).

The patients and community health workers need an incentive to do the screening and triage process. Non-governmental organizations (NGO's) and the church can have an important role in educating patients about the screening and triage benefits. The Flying doctors (NGO) can be an interesting partner for the training of health workers and for the education of the patients about the benefits of being screened. The Flying doctors are well known in the region and have a broad network that they can use. Also the local churches can have an important role in the education part, because they are well trusted by the community.

Philips wants to expand their business in the longer run, therefore it can be useful for them to develop a long-term relationship with the stakeholders. Long-term service or leasing contracts can help to develop this long-term relationship. Also Philips can help to recycle the components of the devices at the end-of-life and create a local network for the maintenance and repair of the devices. Next to providing aftersales services and selling devices to the customer Philips can play an important role in the collection of the patient data. Philips can help the Health Facility to collect and analyze the data. Philips can sell the collected patient data to the government, which can use the data for epidemic management policy, and this will provide a sustainable financial flow.

It can be very expensive for Philips to provide maintenance and repair service in all the regions for all their customers or users. Therefore it can be interesting to work closely together with local partners and repairers for the maintenance and repair of the health measurement devices. The quality of the devices after repair and maintenance is also important for

Philips, because it can have an impact on the company name. Customers expect a certain level of quality and a long lifespan of the Philips health measurement devices, therefore it can be interesting for Philips to have a close relationship with the local repairers and give them the right resources for the maintenance and repair of the devices. A personal online assistant, provided by Philips, can educate and train the local repairer to maintain and repair the devices in a good way. This close relationship with the local repairer give Philips also a lot of insights about the quality of the devices, with those insights can Philips improve their devices (design improvements for maintenance and repair).

The theft of the devices can also be a problem for the development of a circular business model, especially for leasing contracts. Therefore it is important to reduce the incentives for stealing the devices. By providing a sustainable business for community health workers the stealing of the devices can be made less interesting. The device will collect the patient data and send it to the 'Cloud'. It can be interesting to analyze the patient data before the data will be sent to the health facility or the government. This means that the health facility and health workers receive decision support, which can improve the consulting process of the patient.

All those aspects are concluded in a list of hypotheses in chapter 6.4.4, before the final business model can be developed and the aspects which are described in this chapter can be used it is important to analyze and research the hypotheses in a local context. This was the reason for a two weeks field research in Kenya. During this field research the different hypotheses were analyzed and evaluated. In the next chapter the field research will be evaluated more in detail and the results of the field research are explained. All the hypotheses that are described in 6.4.4 will be evaluated in the next chapter.



7. Field research

In the previous chapter the results of the desk research and the workshop are concluded, which led to a clear list of hypotheses. Before these hypotheses can be used for the development of the final circular business model it is important to analyze and evaluate these hypotheses in a local context. In this chapter the results of the field research are concluded.

7.1 Objective field research

The desk research, brainstorm sessions, interviews, and workshop led to many insights which are important for the development of a circular business model for the smart screening and triage devices. Before these aspects can be used for the development of a circular business model specific for the Kenya market it is important to analyze the aspects (hypotheses) in the local context.

With the results of the field research the hypotheses are evaluated. The hypotheses which are described in chapter 6.4.4 are the basis for the format of this chapter.

7.2 Process

During a two weeks field research are these aspects (hypotheses) analyzed and evaluated. The research consisted of questionnaires, brainstorm sessions, interviews, and a workshop at the local Philips office. The questions in the questionnaire are linked to one of the hypotheses, so each hypothesis is covered by a question. This means each hypothesis is analyzed in the questionnaire and interview.

The research involved several stakeholders, namely community health workers (CHW), private/public health workers, nurses, distributors, recycler, managers, local repairer, Kemri (Kenya Medical Research Institute), Ministry of Health, MCF (Medical Credit Fund), and data management companies. In figure 7.2.1 and 7.2.2 some of the stakeholders are visualized.

The results of the questionnaires, brainstorm sessions, interviews, and workshop with all the different stakeholders are concluded in this chapter. The results are processed into graphs and quotes. For the graphs the same scales are used as in the questionnaire. This means that 1 is negative (not preferred, not helpful or not useful), 3,5 is neutral (sometimes helpful or useful) and 7 is positive (preferred, helpful or useful). Below are some examples shown which are used in the questionnaire during the field research in Kenya:



Figure 7.2.1 Questionnaires



Community health
worker
(+/- 50)



Private
health workers
(+/- 5)



Public
health workers
(+/- 10)



Nurses
(+/- 20)

Figure 7.2.2 Interviews



Local distributor



Private facility
managers



Recycling company



Data company

7.3 Distribution

One of the first stages for the circular business model is the distribution of the health measurement devices from the factory (or salesmen) to the local health facilities in Kenya. There are many possibilities for the distribution of the health measurement devices, for example using a local distributor, a foreign distributor, or Philips can distribute the devices by themselves.

7.3.1 Local distributor

During the workshop in The Netherlands it was concluded that local distributors can play an important role in the distribution of the devices locally. The main reasons for using the local distributor are it can reduce the costs and risks, provide a sustainable business for the local community, the local distributor knows the market, and it can develop a close relationship with the local partners. The focus on the local distributor led to the first hypothesis, namely:

‘Philips can use local distributors for the distribution of the health measurement devices’ (workshop Eindhoven).

During the field research in Kenya a local distributor and a private managers from a local health facility were interviewed. The interview shown the local managers prefer to distribute the devices through a local distributor, because a local distributor makes it possible to deliver the devices fast and makes it easier to ask questions about the installation of the devices.

The local distributor is capable (currently distributes Philips products) to distribute the devices to the local health facilities, but the local distributor is not always informed well about the Philips devices. This means the local distributor cannot always answer the questions from the health facility about the functionality of the devices. Sometimes this can affect the reputation of the distributor and Philips (lack of knowledge). Therefore it is very important for Philips to educate the local distributor how the devices work and how they can install the health measurement devices.

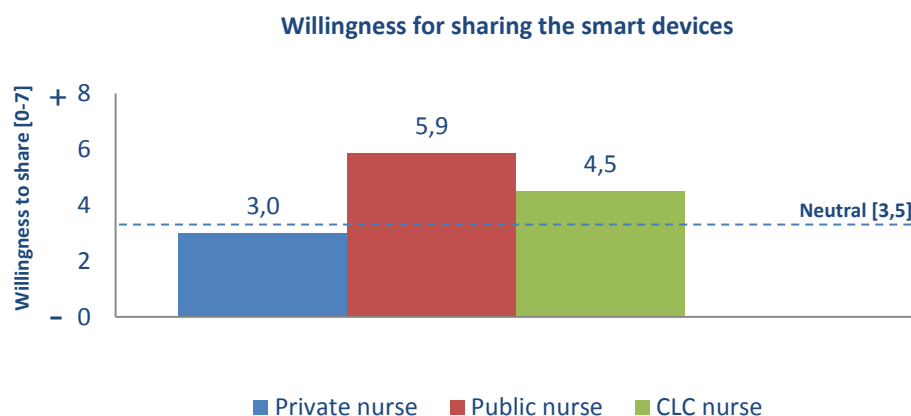
At the end of the interview was concluded a close relationship between the local distributor and Philips is needed. This means the hypothesis is right (Philips can use local distributors), but Philips need to improve the relationship with the local distributor and have to educate the local distributor.

7.3.2 Sharing of the devices

Sharing is also one of the aspects of the circular economy, because of the efficiency and sustainable use. During the workshop in The Netherlands was concluded it can be interesting to stimulate the sharing of the devices, because this can increase the impact of the screening and triage devices. This aspect led to the second distribution hypothesis, namely:

‘Health facilities are willing to share and use health measurement devices from another facility’ (workshop Eindhoven).

Next to the distributor, manager, and manufacturer (Philips) the health workers plays an important role in the opportunities for the sharing of the devices, because the health workers are the main users of the devices. For the local distributor there are no reasons for not sharing, but the health workers and facility managers have some doubts about sharing of the health measurement devices. The results of the questionnaire show a difference in the willingness to share between the different stakeholders. The private nurses (average 3,0) are not willing and the public nurses (average 5,9) are willing to share the devices, see the graph below.



It is important to be aware of the difference between the willingness of sharing in a private or public facility. The main reason for the doubts of sharing the devices is the possibility your device will be broken at another facility (responsibility). The device can appear fine, but inside the technology might be damaged (private manager). It is not possible to analyze how they used and maintained the devices. Given the competition between various private clinics and hospitals it is difficult to

share equipment. They do not want to share devices and services, because the clinics prefer to keep quality indoor (local distributor). If the manager can easily check the quality of the devices (technology) with a Philips help-tool, then the managers are willing to share the devices with another facility for a (profit) fee (private manager).

The public health workers are willing to share the health measurement devices, because they want to help other facilities to help the patient in a good way (health worker). The health workers need to receive a tool for checking the quality of the devices after use. The questionnaire (see graph 'willingness for sharing the smart devices') shows the health workers are willing to share the devices when it is possible to check the quality and accuracy of the health measurement devices. The main reason is that the health workers want to help the patients. It is not important for them who owns the devices (health worker). Philips can provide the infrastructure for sharing the devices, which can be a platform where the different kinds of health facilities are connected to.

If Philips can help the local health facilities to check the quality of their health measurement devices in an easy way then the health facilities, managers, health workers and distributor, are willing to share and use health measurement devices from another facility. This means that the hypothesis is right. There is a difference between the private and public facilities for the willingness to share the devices. It is important to be aware of this difference by developing the infrastructure for the sharing of the devices. This aspect (sharing) contributes to the development of a circular business model, because less devices need to be manufactured and the health workers can use a device at any time.

7.3.3 Conclusion

The two hypotheses about the distribution of the health measurement devices are right, but a few measures are needed before these hypotheses can successfully be implemented. The following measures are needed: educate/train local distributors on how to install the health measurement devices and on how the devices work. This means Philips need to develop a close relationship with the local distributors, which is not yet the case. The sharing of the devices can be possible if the health facilities are able to check the quality of the health measurement devices.

7.4 Payment

The payment of the health measurement devices is an important aspect for the development of a circular business model, because a sustainable financial flow is important for the lifespan of the business model. There are many options for the payment of the devices. During the workshop in The Netherlands the opportunities for the payment of the devices are discussed. Some of the options are the purchase of the devices in one-go, monthly payment, leasing of the devices, and pay-per-use. The conclusion of the workshop led to three hypotheses which will be evaluated in this chapter.

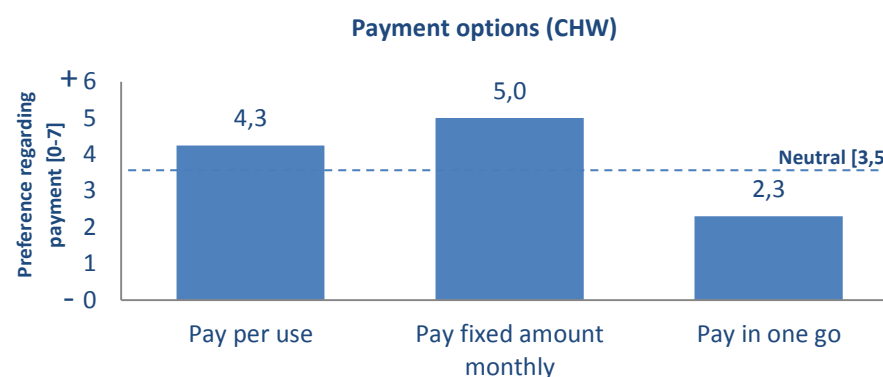
7.4.1 Monthly payment

There are many payment options for the health measurement devices. Before Philips chooses which payment option they prefer and implement it is important to analyze what is preferred and needed locally. During the research the main focus was on the health facility managers and clinical officers, because they are the decisions makers for buying new health devices. Next to the managers are the health workers included, they can give a good indication of what local people prefer.

During the workshop in The Netherlands we assumed that in the Kenyan context health facilities prefer to pay monthly, this led to the following hypothesis:

'Monthly payment is preferred by the local health facilities' (workshop Eindhoven).

The results of the questionnaire show the preferences of the community health workers regarding payment, which gives Philips a good indication of the local preference. In the graph 'Payment options (CHW)' the results are shown, see below:



The results of the interviews with the clinical officers and private managers show some different results. The managers prefer to pay in-one-go for the health measurement devices, because they prefer to have a clear overview of the costs they pay for the smart health measurement devices (private manager). For this reason Philips will focus on the in-one-go payment for the devices.

Monthly payment is not preferred by the public and private health facilities. The Kenyan people (managers) prefer to know specifically what they have to pay and want to pay in-one-go, if that is possible. Private health facilities prefer to purchase health measurement devices under the 1000.000 Kenyan Shillings in-one-go (private manager).

7.4.2 Pay-per-use

New business models are needed, also in developing countries like Kenya. That was also the reason for focusing on new ways of doing business, the payment options is one of these aspects. The different frameworks of business models which are discussed in the previous chapter also include the pay-per-use payment option, in this case the facility pay for the use of the devices (service) and not only for the devices itself. This led to the following hypothesis:

‘It is preferred by the local customers to pay-per-use (access to the devices) instead of purchasing the devices’ (workshop Eindhoven).

In the Kenyan context the payment per-use is not well implemented in the healthcare sector, which makes it hard to use this model. But it also gives Philips the opportunity to be a pioneer in this field. The managers of the private facility are open for new payment options, but it is very important for them to know what they pay. Monthly payment is not preferred by the private managers, but prepaid credit on the devices is (private manager). Prepaid credit give them more control over the costs of the health measurement devices, because they will never pay more than the money they add on the devices. On the other hand prepaid credit has a negative impact on the quality of healthcare, because without prepaid credit the device is useless. If the prepaid credit is zero during a busy day this will have an impact on the quality of healthcare.

Currently, the pay-per-use model is not well implemented in the Kenyan healthcare sector, but there are opportunities for implementing it for the devices. A pilot project is needed to analyze how the in reality works. The hypothesis is right, there are opportunities for new payment options. But before Philips can implement the pay-per-use system a pilot project is necessary.

7.4.3 Long-term relationship

During the workshop in The Netherlands the topic of the development of a close and long-term relationship with the customer was an important aspect, this led to the following hypothesis:

‘Monthly payment makes it possible for Philips to build a long-term relationship with the customer’ (workshop Eindhoven).

A long-term relationship with the customer is important for a sustainable business, because the customer will trust the manufacturer (Philips) and the customer will buy his products from Philips in the future. But a clear relationship with the customer is also important for Philips to receive insights about the needs of the customers and to receive signals about changes in the market.

During the interview with the local distributor it was concluded that monthly payment in a Kenyan context only will provide a formal relationship with the customer. Customers do not prefer to have monthly contracts (local distributor). The local health facilities prefer to have a close relationship with Philips, because at this moment they have many questions about installation, use and repair, but they don’t know how to contact the right Philips contact persons (Clinical officer).

A close relationship with Philips can be generated by developing good and sustainable aftersales services. Currently, Philips only sell their products, but doesn't invest in the service behind the products. Concluding, monthly payment will only develop a formal relationship, which will not lead to a long-term relationship. Providing better aftersales services will help Philips to develop a long-term relationship.

7.4.4 Pilot market

The healthcare facilities in Kenya are divided between the public healthcare sector and the rising private sector. Both sectors are very different in decision management, financial budgets, and criteria for the health measurement devices. During the workshop in The Netherlands we decided to focus on the private health sector, because of the rising market and the financial budgets. This led to the following hypothesis:

‘The private health sector can be an interesting market for the introduction of new devices’ (workshop Eindhoven).

Before a grounded decision can be made it is important to analyze both sectors. During the field research in Kenya different kinds of stakeholders were interviewed. This research showed that the public healthcare market has many difficult protocols and processes before a new smart screening and triage device will be accepted (Kemri, 2015). The budgets and criteria for the smart devices are different (Clinical officer) for each county (local government), which makes it hard to develop a circular business model that can be used for the whole Kenyan market. But next to this the corruption in the public sector is still a problem (local distributor).

In contrast to the public health sector, in the private sector it is easier to implement the new smart devices, because the private facilities can buy their own equipment and health measurement devices (private manager). The private facilities also have more budget to spend for smart devices, which makes the private sector a better market to start with. During the workshop in Kenya it was also mentioned that if the smart devices are accepted and used by the private sector for a few years, then the public sector will also implement the smart devices more easily. For the public sector it is important to know and analyze the quality and the reliability of the devices (workshop Nairobi).

With these insights we can conclude that the hypothesis is right: the private healthcare sector can be an interesting market for the introduction of new devices. Start with the private sector and use the experience of the use of the devices in the private sector for the implementation of the devices in the public healthcare sector.

7.4.5 Conclusion

The field research in Kenya has given us many new insights about the payment of smart screening and triage devices. The development of a long-term relationship with the customer (health facilities) and other stakeholders can be seen as an essential aspect for the development of a sustainable business. In Kenya monthly payments are not preferred and therefore it is also not possible to develop a long-term relationship by using monthly payments. Philips can set up long-term business by providing good and sustainable aftersales services. The pay-per-use concept is currently not used in Kenya, but there are some opportunities. When using a pay-per-use model it is important that the manager has a clear overview of the costs, therefore automatic payment will not work, but prepaid credit can be possible. When introducing the new smart

devices it is important to focus on a sustainable market. The field research showed that the private sector can be an interesting market for introducing the new smart measurement devices, because they make their own decisions, have budget for smart devices and it is a rising market.

7.5 Service

The service around the smart screening and triage devices is one of the most important aspects for the development of a circular business model, specifically in the Kenyan market. The repair and maintenance services are aftersales services which extend the lifespan of the devices, these aftersales services will be discussed more in detail in the following subchapters.

7.5.1 Competitive advantage

The prices of the Philips health measurement devices are much higher than the prices of the Chinese devices (1/6). It is necessary for Philips to add more value to the health facility with the smart devices, in comparison with the Chinese devices. One of the competitive advantage of Philips is the quality of the smart measurement devices. During the workshop in Eindhoven we concluded that Philips has to add more value to their products to compete with the Chinese products. Customer-focused aftersales service will add this extra value to the Philips products and this will provide a competitive advantage.

This led to the following hypothesis:

‘Customer-focused aftersales service can be Philips competitive Advantage’ (workshop Eindhoven).

The field research in Kenya showed that Philips relationship with their customers and the service around the smart devices is not customer-focused at all. Philips only sells their products to local health facilities and then stops the conversation with the customer (local distributor). This means that the health facility receives no training or education on how to use the devices well and what the options of the devices are (clinical officer).

During the interview with the local distributor it was concluded that Philips can do a lot more in the field of providing customer-focused services. There is a great need for aftersales services, from the local distributor, managers and health workers. All these stakeholders want to know how the devices works, how they can maintain them and where they can repair the devices (local distributor).

The hypothesis is right Philips can develop a competitive advantage by providing customer-focused aftersales services, there is a great need for more service in Kenya in specific in the health sector. Currently the services provided by Philips are not customer-focused at all, so there are many opportunities for improving the aftersales services.

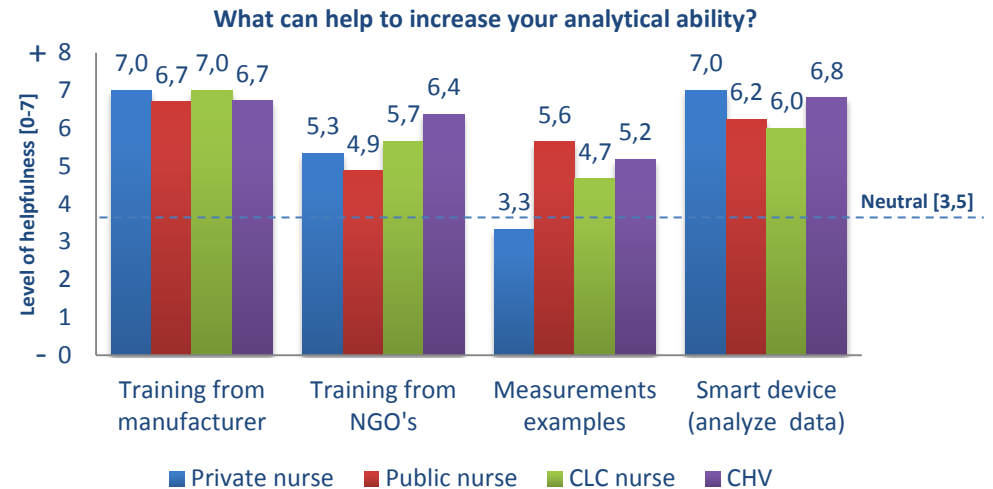
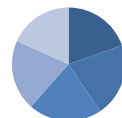
7.5.2 Training and education

There are many ways to train and educate health workers, distributors and managers. In this part the training and education for the good use of the devices is evaluated, as well as how to increase the ability of health workers to analyze measurements. The training and education can be provided by different kind of organizations, NGO's (Non-governmental organizations) or the manufacturer (Philips). During the workshop in Eindhoven we concluded that NGO's can play an important role in the education and training of all the stakeholders, which led to the following hypothesis:

'Training provided by NGO's can extend the lifespan of the devices (good use of the devices)' (workshop Eindhoven).

This hypothesis was formulated, because from our perspective NGO's have a closer relationship with the local health facilities and their health workers in the cities and rural regions. During the workshop this was the main reason to use the NGO's for education and training. Currently, many NGO's are active in Kenya, for instance 'The Flying Doctors' and 'The Red Cross'. Philips works closely together with 'The Flying Doctors', which was the main reason to focus on 'The Flying Doctor' for the education and training of the health workers.

During the field research in Kenya this hypothesis was evaluated. The overall reaction about the training and education was positive, all the health workers want to receive training and education to improve their knowledge (health workers). The circle diagram on the right side shows the ability level (colors) of the health workers and their willingness to receive (size of the pie) training. The



results show that all the health workers (from beginners till experts) want to receive training. For this reason it is not interesting to focus on one spectacular expert group. The graph above show what kind of aspects can help the health workers to increase their ability to analyze measurement data (questionnaire, field research).

The graph (scale of utility) shows the health workers prefer to receive a training from the manufacturer, which will focus on the good use of health measurement devices and education for increasing the ability of health workers to analyze patient data. For this reason it is interesting for Philips to develop a training and education program, which will be part of the circular business model. Next to the possibility to receive training, the smart device also preferred by the health workers because the health workers trust the Philips devices and have high expectations about their functionality (questionnaire, field research).

Next to the Health workers it is very important to educate the local distributors about the use and installment of the devices, because they

have to share this knowledge with their customers. The distributors prefer to receive this training from the manufacturer (Philips), not from NGO's (local distributor). The main reason is that the distributor wants to have a close relationship with the manufacturer and the training can be the first step to this close relationship.

The training and education of the different stakeholders is very important for the good use of the devices and the lifespan of the devices. The appreciation for the smart screening and triage devices will be better if the different stakeholders know how to optimally use the devices.

The hypothesis is right: NGO's can extend the lifespan of the devices by providing training for the good use of the devices, but the stakeholders prefer to receive this training from the manufacturer (Philips). This training can help to develop a close relationship with the different stakeholders. Philips can for example educate the NGO's and local distributors on how to use the devices in a good way and they can pass this knowledge on to the local facilities, in specific to the health workers.

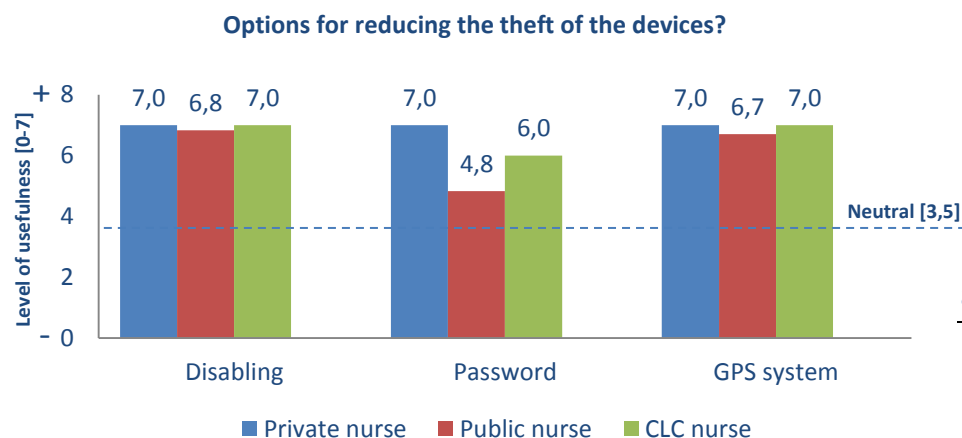
7.5.3 Reducing the theft

In developing countries everything that has some value is tempting for theft (workshop Eindhoven). As a manufacturer it is very important to be aware of the theft. Philips can design the devices in such a way that it reduce the incentives for theft. During the workshop the 'GPS tracking' system was discussed, which led to the following hypothesis:

'GPS tracking 'find-my-device' can reduce the theft of the smart screening and triage devices' (workshop Eindhoven).

During my desk research and the workshop in Eindhoven the focus was mainly on the theft by volunteers and externals, but during the field

research in Kenya some new insights were obtained. Most of the theft is by employees of the health facilities (clinical officer). For this reason a password is not sufficient to reduce the theft of the devices, because all the employees will know this password (nurses). The results of the questionnaire show that the password is not preferred by the public nurses (questionnaire). These results are shown in the graph below.



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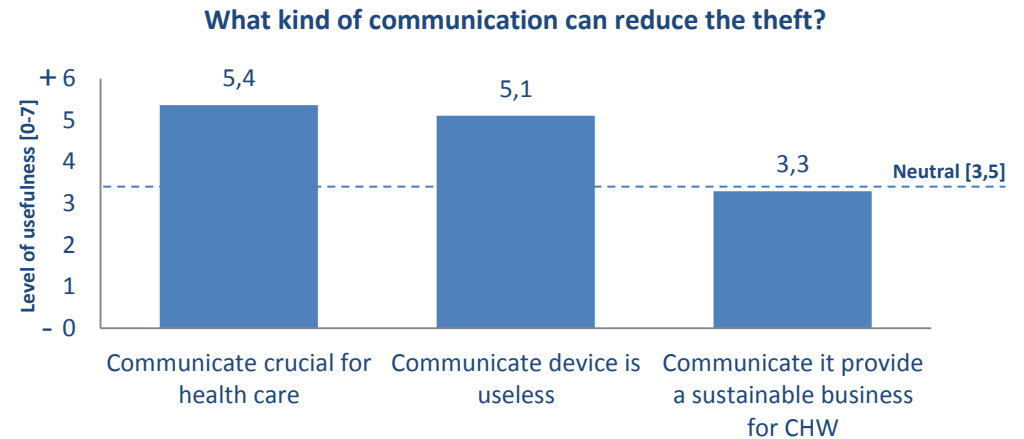
The graph shows the results of the question 'what do you think could reduce the theft of the health measurement devices?' (questionnaire, field research). There were many options in the questionnaire: remote disabling of the devices after it is reported stolen, if the devices should be equipped with GPS (traceable), if the device should only work with a personal password, fingerprint and 'what else do you think can help?'. The results from the questionnaire show that the disabling and traceability (GPS) of the devices are the most important for reducing the theft of the smart screening and triage devices (questionnaire). Next to

the GPS and traceability it is very important to make the health workers responsible for the good use and theft of the devices (workshop Nairobi). A nurse from a public hospital quoted:

‘This is a device that lauds in many hands of health workers, therefore handing (responsibility) over after every shift is very important’ (nurse).

This means that responsibility and transparency (about who uses or has used the device) is a very important aspect for the reduction of the theft of the smart devices. The use of passwords is not sufficient, because also employees (who know the passwords) will steal the devices. A new aspect that was concluded is focusses on the responsibility of the health workers about the devices, Philips needs to develop a system that will increase the feeling of responsibility of the health workers.

In the questionnaire for the community health workers (CHW) an extra question about the reduction of theft is included. The question focusses more on communication than on specific product aspects which can reduce the theft. The graph ‘What kind of communication can reduce the theft?’ shows the results of this question. The results of the questionnaire for the CHW show communication will not help to reduce the theft of the smart devices. The total average of the results are around scale 4, this means that ‘it will sometimes help’ to reduce the theft of the devices. The results of the products aspects (GPS and disabling) show higher averages, for this reason Philips needs to focus on the product aspects for the reduction of the theft. The chance of success is in this case higher.



During the workshop in Eindhoven we focused on the traceability of the devices and the use of passwords. The field research showed the traceability and disabling of the devices can help to reduce the theft of the devices, in contrast to the use of passwords which are not preferred by the health workers. This means the hypothesis which was formulated during the workshop in Eindhoven was right, with the exception of the use of passwords. Philips has to develop a system/program that can trace (GPS) and disable the devices.

7.5.4 Conclusion

This part focused on the service provided by Philips and only the aftersales, training and traceability services are included. The repair, maintenance and recycling services are discussed in another chapter. Philips can develop a competitive advantage by providing customer-focused aftersales services, because there is a great need for more service in Kenya, in specific in the health sector. Currently, the services provided by Philips are not customer-focused at all. Therefore there are opportunities are there for improving the aftersales services. Philips can

improve the good use of the devices and with this the lifespan of the devices by working closely together with NGO's. In a collaboration with NGO's Philips can train/educate health workers and local distributors on how to install and use the devices, for example educate the NGO's and local distributors on how to use the devices in a good way and they will pass this knowledge to the local health facilities and workers. Next to the aftersales services and training is the reduction of theft evaluated in this part. The focus was mainly on the traceability of the devices and the use of passwords. The field research showed that the traceability and disabling of the devices can help to reduce the theft of the devices. This means the formulated hypothesis was right.

7.6 Data management

The collection and management of measurement and patient data is an important aspect for the quality of healthcare. The collected data need to be trusted and accurate. In western countries patient data is stored in a digital database, in the more upcoming markets (like Africa) patient data is stored in paper based reports or not well connected digital database. In the last few years is Africa, in specific Kenya, entering in the more digital world.

7.6.1 Need for digital patient and measurement data

Many things (mobile payment) in Africa are transforming from a paper based to a more digital way of collecting and managing data. Currently, Africa is the continent with the most 'white spots' on the map, these spots show the areas without internet or mobile connection. In the coming years will the digitalization of Africa accelerate, the main reason are the urge of the technology giants. These technology giants want to connect everything and everyone.

'The iHub in Nairobi is home to 150 start-ups where they are busy with developing an app which makes crowd supplied information accessible through the informal public. In northern Kenya has been fashioned radio waves tapped to bring free broadband internet. This method can be rolled out worldwide and costs almost nothing' (Tegenlicht, 2015).

There is a big need in the healthcare sector for a more digital database, for the health workers to compare the patient data, for the health facility to analyze the workflow, and for the government to have a good overview of the diseases in each county (workshop Nairobi). During the workshop in Eindhoven was the following hypothesis formulated:

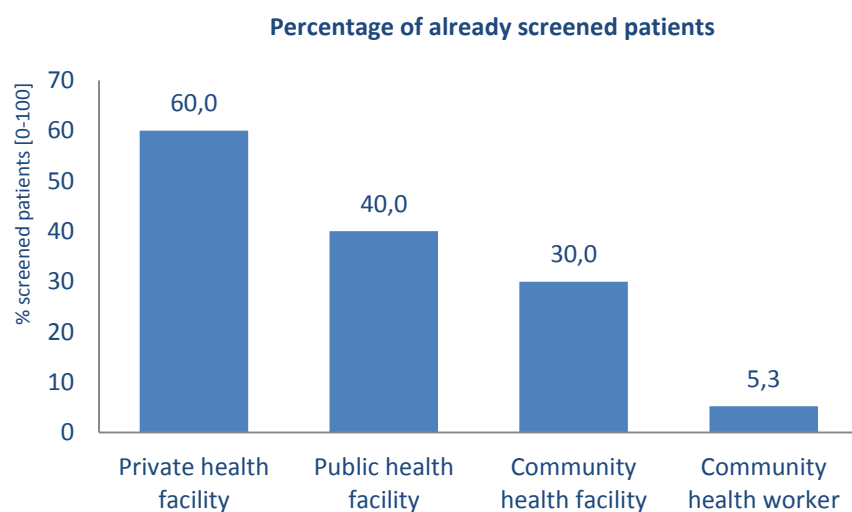
'In Kenya is a big need for patient and measurement data, the smart screening and triage devices should make it possible to collect this data' (workshop Eindhoven).

The field research in Kenya shows there is a big need for patient and measurement data, because of the high patient flow and the current paper based reports. The technological companies which are settled in Kenya will provide the infrastructure for developing a more digital database with patient and measurement data (workshop Nairobi).

Africa is a continent with many 'white spots' on the map, areas without internet or mobile connection. This will change in the coming years because a lot of technical companies invest a lot of money to improve internet connection. This makes it possible to develop a digital patient and measurement database, which will improve the patient flow and replace the paper based reports. The replacement of paper based report has a positive effect on the circular business model.

7.6.2 Patient and measurement data

The health workers want to use the database to compare previous patient data with the current measurements. This give the health workers a good indication of the process of sickness of the patient. The results of the questionnaire (See graph: 'Percentage of already screened patients') show CHW (5,3 % of the patients is already screened) are the first who screen and triage patients, the community health facilities (30% of the patients is already screened) and public hospitals (40% of the patients is already screened) receive a report from the CHW (the patient brings this report with him/her). In the private facilities are 60% of the patients already screened by another public facility or CHW. Most of the reports from the CHW are paper based and a small percentage send the data to the patient or health facility via SMS. Now it is interesting to know if this data is well trusted/used and what the preferences are for digital or paper based data.



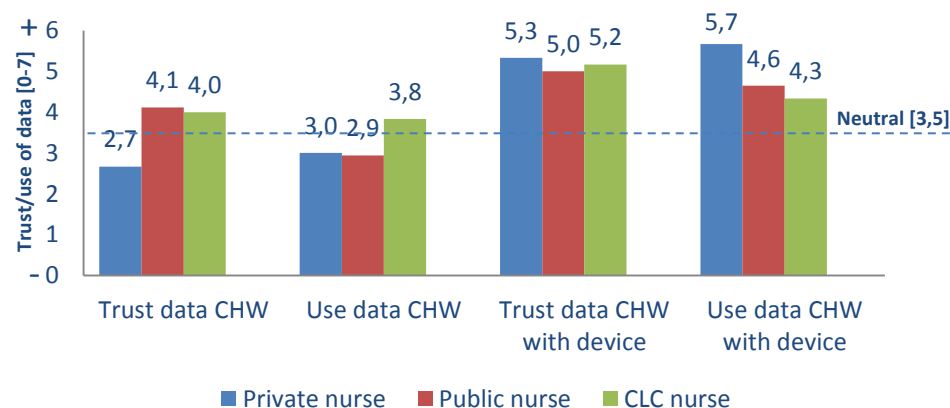
Most of the reports from the CHW are paper based and a small percentage send the data to the patient or health facility via SMS. The results show the public health facilities receive 30%/40% measurement data from another health worker.

The next step is to know if the health workers are willing to use the data from a CHW, because most of the data given by the patients to the health facility is from a CHW. The accuracy of the measurement data is an important factor for the health workers. The education level of the CHW is one of the elements which have an impact on how the health workers trust and judge the collected measurement data from the CHW.

The results of the questionnaire show the health workers do not trust the collected data from a CHW, this has an impact on the use of the data. The results of the questionnaire are visualized in the graph 'Trust and use of the CHW data' (see the graph on the next page). The public nurses will sometimes (average 4.0) trust the data and never or sometimes use the data (average 3.3). The private nurses never or sometimes (average 2,7) trust the data, and never or sometimes (average 3,0) use the data from a CHW.

The smart screening and triage devices will help the CHW to collect accurate measurements. This has an impact on the trust and use of the measurement data collected by the CHW. The graph 'Trust and use of the CHW data' shows the average of trust and use of the data increase. The health workers will trust the measurement data with an average of 5,2 out of 7 and use the measurement data from a CHW with a smart device sometimes (average of 4.8).

Trust and use of CHW data



The results of the questionnaire shows 40%/30% of the patients who go to the public health facilities are already screened by a CHW. At the private facilities are 60% of the patients already screened by another health worker. The health workers do not trust the collected measurement data from the CHW and for this reason not use the data. The main reason is the low education level of the CHW and the shortage of good health measurement devices. The field research shows the health workers are willing to use the data from a CHW when they use a smart screening and triage device because of the good accuracy of the devices.

7.6.3 Measurement data report

There are many forms for reporting the measurement and patient data, paper/digital based report, SMS message or an oral conclusion from the doctor. Currently, in the community level (level 1, 2 and 3) health facilities are most of the reports paper based. In the higher level (level 4 and 5) and private health facilities they use a digital database, but still receives the patient a paper based report. For the development of a smart device and the service around the device it is important to know what kind of report from the device is preferred by the health workers and patients. The

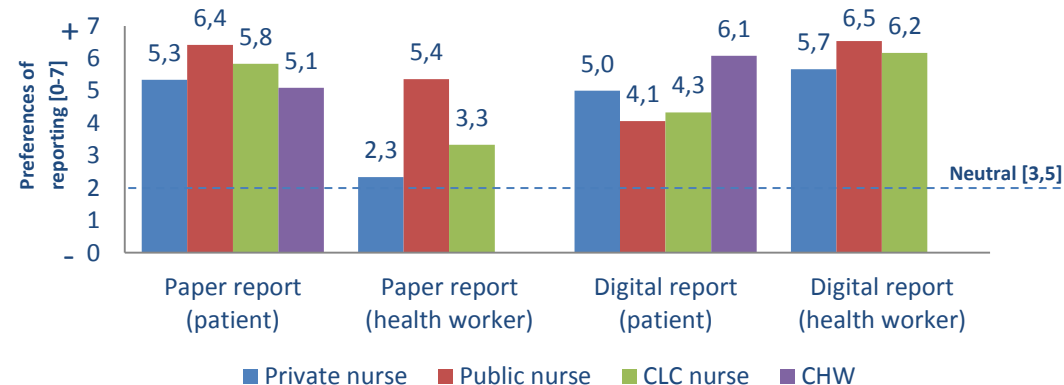
results of the field research give a good indication of what kind of reports are preferred. The results of the questionnaire show, the paper based reports are preferred by the patients with an average of 5,7 (out of 7,0) and the digital report with an average of 4,9 (moderate preference). The community nurses and the private health workers have a low preference for the paper based reports (average of 2,8 out of 7,0), but the public nurses prefer the paper based reports with an average of 5,4.

‘Currently, we use measurement cards for reporting the patient measurements. We give these cards to the patient and the patient can give this card to the next health worker. This system works well and therefore I prefer a combination of paper and digital based reports’ (Public nurse).

The health workers have a high preference for the digital reports with an average of 6,1 (out of 7,0). The graph ‘preference kind of report’ visualize the results of the questionnaire.

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Preference regarding reporting data?



The health workers mention that when a new device is introduced they need to explain this new device to the patients. The patients trust the health workers they will help them in the best way. The new device or the way of reporting must be preferred by the health workers. The health workers will persuade the patients about the use of the new device and new way of reporting (health worker).

In the community level (level 1, 2 and 3) health facilities are most of the reports paper based. In the higher level (level 4 and 5) and private health facilities they use a digital database, but still receives the patient a paper based report. The patients prefer the paper based reports and the health workers prefer the digital reports. The preference of the health workers is more important than the preference of the patients. The health worker will persuade the patient about the new devices and way of reporting. For the new device the manufacturer (Philips) needs to focus on the digital reports and visualizations (instructions) for persuading the patients about the value of the digital reports.

7.6.4 measurement and patient data sharing

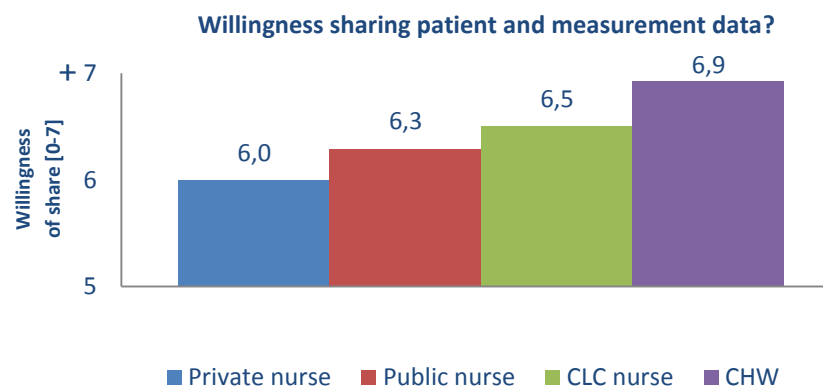
In 7.6.1 is the need for more digital data described and the results in 7.6.2 shown 30%/40% of the patients are already screened by a CHW before they go to a public facility. The data from the CHW is used for comparison of measurements. The sharing and collecting of the measurement data is the responsibility of the patient, the patient need to bring the report from the CHW or another facility when they go for a consultant (clinical officer). It can help the patient when the reports are automatically shared to the right facilities or institutions. In this case is the patient and measurement data secured and always available.

During the workshop in Eindhoven were the following hypotheses formulated:

*‘Philips can use the data for tracking the device flow, this data can help to improve the devices’
(workshop Eindhoven).*

*‘The health facilities can transfer the collected data to each other, this can improve the workflow efficiency’
(workshop Eindhoven).*

The results of the questionnaire show (see graph ‘willingness sharing data’) the health workers are willing (average 6,4 out of 7,0) to share patient and measurement data. In this case the securing of the confidentiality of the patients is very important (workshop Nairobi). It should not be possible to link the measurement data to a specific patient name or personal number. The patients data must be linked by a code (not traceable for externals) instead of a name or personal number.



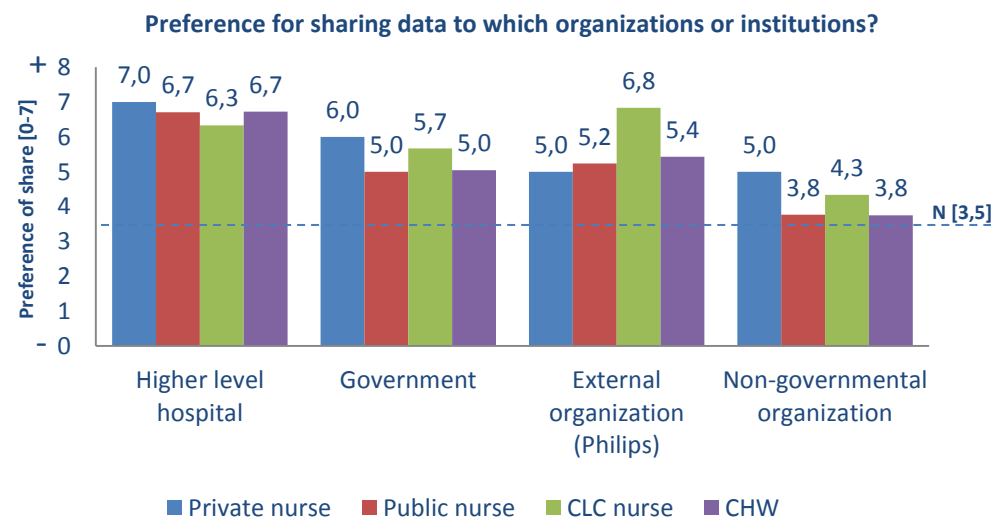
The results show the willingness of the health workers to share the patient and measurement data, but still it is important to know to which institutions or organizations the health workers are willing to share the patient and measurement data. The results of the questionnaire give a good indication of the preference of institutions and organizations for sharing the patient and measurement data. In the graph 'Preference for sharing data to which organizations or institutions' are the results of the questionnaire visualized.

The results show, health workers have a high preference for sharing the patient and measurement data with a higher level hospital (average 6,7 out of 7,0) and a low or moderate preference to share the data with a non-governmental organizations (average 4,2 out of 7,0). The health workers have a moderate till high preference for sharing data with the government or external organizations.

In particular the 'CLC nurses' has a high preference for sharing the data with an external organization, in specific Philips, because the 'CLC nurses' already work close together with Philips in the Community Life Center.

'We are willing to share the data with Philips, because Philips can use this data for making their devices more accurate (use of the devices data)' (health worker)

The results of the questionnaire and the above statement from the health worker confirmed the hypothesis, Philips can use the data for tracking the device flow. This data will help Philips to improve the devices, because Philips can analyze how the smart health measurement devices are used by the health workers.



In the graph 'Preference for sharing data to which organizations or insitutions' is shown the health workers have a high preference for sharing the patient and measurement data with a higher level hospital. These results confirm the following hypothesis, 'the health facilities can transfer the collected data to each other, this can improve the workflow efficiency'. The shared data can be used by the other health facility for comparison of their own data (patients sickness flow).

The results of the questionnaire show the willingness of the health workers to share their patient and measurement data with other institutions and organizations. The health workers have a high preference for sharing the patient and measurement data with a higher level hospital (average 6,7 out of 7,0) and a low or moderate preference to share the data with a non-governmental organizations (average 4,2 out of 7,0). The health workers have a moderate till high preference for sharing data with the government or external organizations.

7.6.5 Conclusion

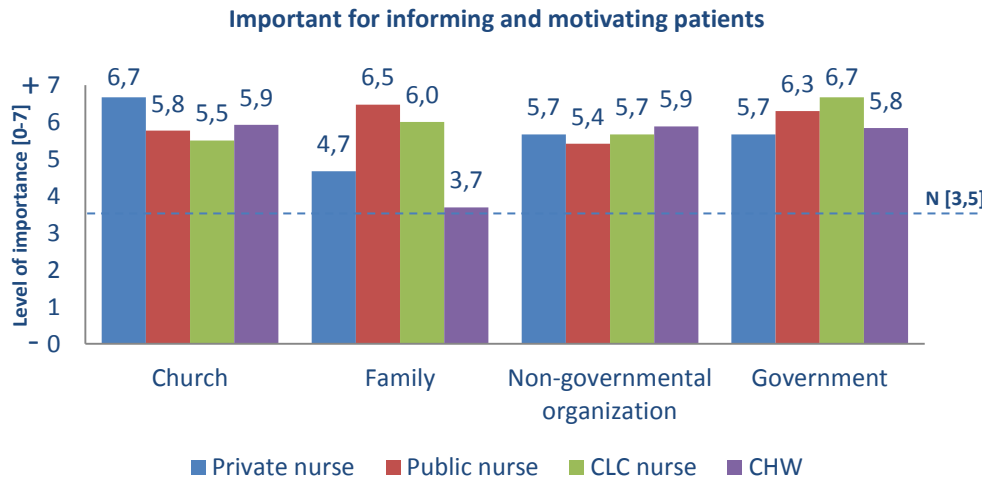
Africa is a continent with many 'white spots' on the map, areas without internet or mobile connection. This will change in the coming years, a lot of technical companies are investing a lot of money to improve internet and mobile connection. This makes it possible to develop a digital patient and measurement database. Currently, 40%/30% of the patients who go to the public health facilities are already screened by a CHW, for the private facilities this is 60%. The collected measurement data from the CHW is not trusted and for this reason also not used. The main reason for not trusting the data is the low education level of the CHW and the shortage of good health measurement devices. The field research shows the health workers are willing to use the data from a CHW when they use a smart screening and triage device. In the community level (level 1, 2 and 3) health facilities are most of the reports paper based. In the higher level (level 4 and 5) and private health facilities they use a digital database, but still receive the patients a paper based report. The health workers are willing to share their patient and measurement data with other institutions and organizations. The health workers have a high preference for sharing the patient and measurement data with a higher level hospital (average 6,7 out of 7,0) and a low or moderate preference to share the data with a non-governmental organizations (average 4,2 out of 7,0). The health workers have a moderate till high preference for sharing data with the government or external organizations. These results give a good overview of the sector and the willingness of the local people. For Philips it can be interesting to invest in more data oriented health measurement devices and the service for collecting and analyzing this data.

7.7 Motivating patients

The smart health measurement devices will screen and triage patients. Before patients will accept and see the benefits of the devices it is important to inform them about the necessity of being screened. Next to informing it is important to motivate the patients to go for a health check by a health facility or CHW. For this reason Philips needs to know which organization currently informs and motivates patients, because a collaboration with these organization can improve the success of the devices. During the workshop in Eindhoven the following hypothesis was formulated:

'The church and NGO's can play an important role in informing and motivating patients to go for a health check in/by a health facility' (workshop Eindhoven).

The results of the questionnaire show the importance of all the stakeholders in informing the patients. In the Graph 'Importance for informing and motivating patients' are the results of the questionnaire visualized. Currently, the church (average 6.0), non-governmental organizations (average 5,7) and the government (average 6,1) have an important role in motivating patients (from the perspective of the health workers). The family plays an important role in the more urban regions (public and CLC nurses), but in the more rural regions (private facilities and CHW) the family has a less important role in informing and motivating the patients. By analyzing the graph can be concluded that the hypothesis is well-founded, because the church has an important role in informing and motivating patients. The manufacturer (Philips) has to work close together with the church for promoting the smart health measurement devices.



The results show which stakeholders are important for motivating and informing patients. In specific the church, NGO's and the government have an important role in motivating and informing the patients.

7.8 Repair

The repair opportunities are one of the most important aspects for the development of a circular business model for the screening and triage devices. There are many aspects that need to be evaluated before the system for repair works optimally. During the workshop in Eindhoven we discussed the repair of the devices, which led to many hypotheses, in this part these hypothesis will be evaluated and concluded.

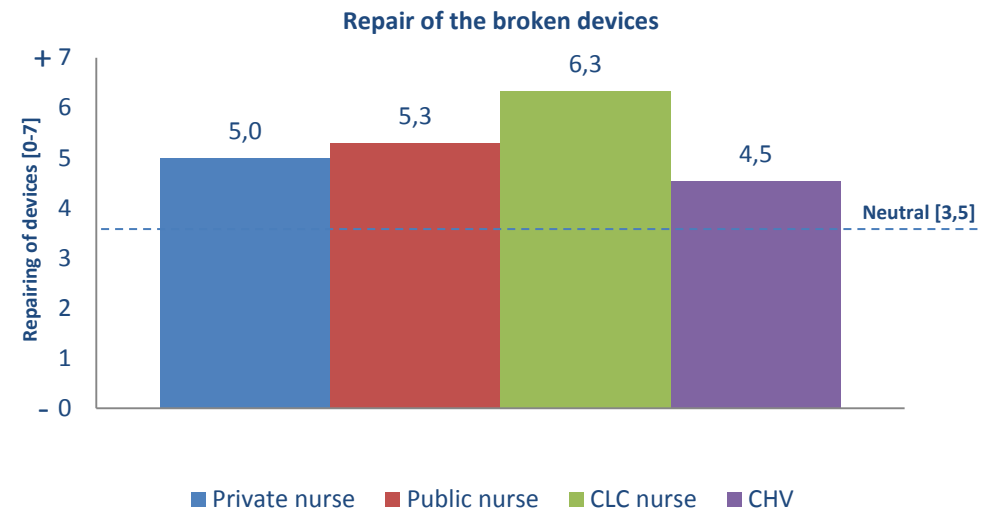
7.8.1 Local repair

One of the elements of a circular business model is a local sustainable business. Local repair of the smart devices can improve the opportunities for local repairers to expand thir business. Next to the sustainable

business for local companies, the use of local repairers has many other sustainable opportunities. Local repair reduces the emissions and costs of the distribution of the devices, makes it possible to repair devices faster and improves Philips relationship with the community (marketing). The following hypothesis was formulated during the workshop in Eindhoven:

'The broken smart screening and triage devices can be repaired by a local repairer' (workshop Eindhoven).

Currently, there are opportunities to repair the health measurement devices by a local (private) biomedical engineer. These biomedical engineers can play an important role for the local repair of the smart measurement devices. Collaboration between the local distributor, a local biomedical engineer and Philips can be a good system for the opportunities for local repair (workshop Nairobi). The graph below shows that the health workers sometimes (average of 5) send the broken devices for repair.



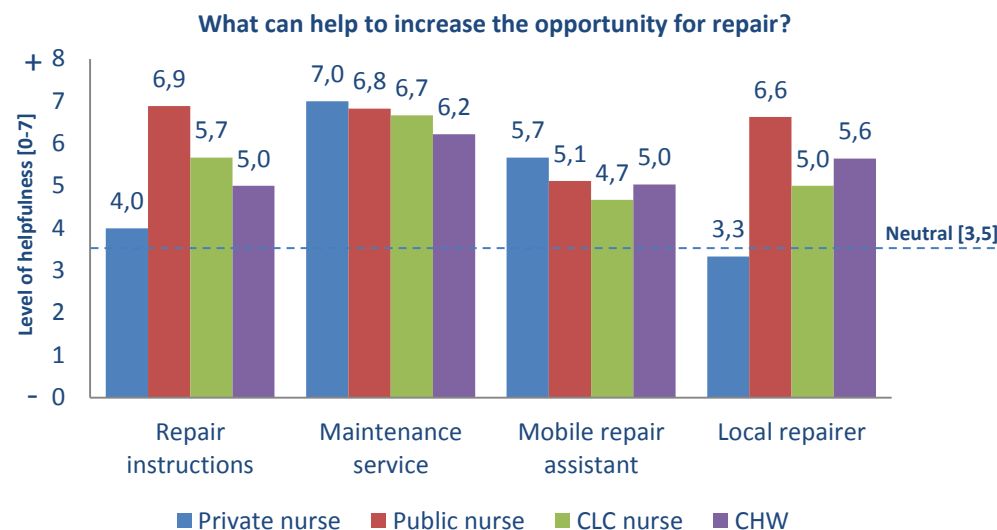
Despite the fact that there are opportunities for local repair, health facilities are currently not using these private biomedical engineers. The main reason is that the managers (or clinical officers) do not trust the biomedical engineers, so most of the health measurement devices are dumped on an e-waste dump (private manager). This is mainly the case at private health facilities, the graph 'what can help to increase the opportunity for repair?' shows that private nurses do not trust the local repairer. Most of the public health facilities have a well trusted internal biomedical engineer (clinical officer). This can be linked to the second hypothesis, which was also developed during the workshop in Eindhoven:

'For the maintenance and repair of the Philips devices qualified people are needed' (workshop Eindhoven).

The local managers and clinical officers do not trust the local biomedical engineers, so for this reason they do not repair their devices at all. Only qualified repairers are trusted by the local health facilities (private manager). This means that Philips has to train and educate local biomedical engineers to make them qualified to repair the Philips smart devices.

'Philips has to train local biomedical engineers on how they can repair the broken devices in a good way. Philips must acknowledge the local biomedical engineer with a certificate or mark' (private manager).

The results show that Philips can play an important role in improving the reliability of the biomedical engineer. During the interviews with the managers from the private facilities, interviews with the clinical officers (public facility) and during the workshop it was mentioned the reliability



of the local biomedical engineers will increase when Philips will train and educate them on how to repair the Philips smart devices in a good way.

The maintenance service, provided by Philips, is by the health workers scored as an aspect which can help to increase the opportunities for repair of the broken devices. Currently, Philips has a maintenance service for the more expensive health measurement devices, not for the cheaper (under the 500 dollar) ones (Business developer). For Philips it can be interesting to focus on the opportunities for providing a maintenance service for the less expensive health measurement devices, from a circular and sustainable focus.

Currently, local biomedical engineers can repair the broken health measurement devices, but they are not trusted by the managers (in particular private managers). Philips can play an important role in improving the trust in the local biomedical engineers by providing training for the local biomedical engineers. Philips has to acknowledge the

local biomedical engineer with a certificate or mark. The hypothesis is right, it is currently possible, but Philips has to improve the trust in the private biomedical engineers.

7.8.2 Online/mobile assistant

The smart screening and triage devices will be sold to hospitals in the urban regions and health facilities in the more rural regions. It is difficult to have a close relationship with all these facilities and it is not always possible for them to contact a Philips representative. To improve the opportunities for good maintenance, repair and to build a close relationship with the stakeholders it is important that the health facilities can easily contact the manufacturer (Philips). During the workshop in Eindhoven this subject was discussed, which led to the development of an online or mobile assistant. This online or mobile assistant makes it possible for all the health facilities in the urban and rural regions to contact Philips. The following hypothesis was formulated:

‘An online or mobile repair assistant can improve the opportunities for maintenance, local repair and the development of a close relationship with the manufacturer (Philips)’ (workshop Eindhoven).

The online (mobile) repair assistant is available 24 hours day for questions about the maintenance, repair or information support of the smart devices. The online or mobile repair assistant can help to solve small defects and can advise the health facility where to repair bigger defects.

‘Most health devices brought to this facility, usually become useless when they break down, because the health maintenance department is never trained on how to repair the devices’ (health worker).

The field research in Kenya showed that this online or mobile repair assistant is well preferred, both by the managers, clinical officers and health workers. During the workshop with all the different stakeholders the online or mobile repair assistant was one of the most important examples of opportunities for repair of the smart screening and triage devices. The stakeholders currently do not know how the devices work and who they can contact for assistance (workshop Nairobi). The results of the questionnaire for health workers (see graph ‘What can help to increase the opportunity for repair?’) showed that the mobile assistant is preferred with an average of 5 (out of 7). When the assistant is provided by Philips this average will increase. The mobile repair assistant is most preferred by the private facilities and the CHW, because they have no in-house biomedical engineer.

‘Online repair is good and helpful, only when it is provided and explained by Philips’ (Nurse).

An important aspect for the online or mobile repair assistant is that it is provided and explained by Philips. The stakeholders only trust Philips assistants or assistants that are trained and educated by Philips. This is the same as for the local repairer (health worker).

The hypothesis is right: an online or mobile repair assistant can help, in particular the health facilities which are settled in the more rural regions. It is important the assistant is easy to contact and it is provided by Philips. To make the online or mobile assistant sustainable the health facility is willing to pay a fee. This fee will be part of the total costs for the aftersales services (private manager). The health facilities prefer to pay a yearly fee for the aftersales services, including the online or mobile repair assistant (private manager). For the public facilities it is difficult to pay an

extra fee for the online or mobile repairer assistant. For this reason the focus will be on the private health facilities.

7.8.3 Reparability

Next to providing good aftersales services and an online repair assistant it is very important that the devices are repairable. A few design aspects can be very important for the opportunities for repair. During the workshop in Eindhoven we discussed a lot of aspects that can be important for the reparability of the devices, namely that the devices are easily to disassemble, construction drawings and coding of the components. These aspects led to the following hypothesis:

*‘Easy disassembling, construction drawings and coding of the components can improve the reparability of the smart measurement devices’
(workshop Eindhoven).*

This hypothesis is evaluated during the field research in Kenya. The hypothesis is processed in the questionnaire for the health workers and discussed during the workshop with a local biomedical engineer. The questionnaire showed some interesting results. When the health worker mention that they never repair the broken devices their motivation is that the devices are not trusted anymore (questionnaire, field research)

*‘I never send the measurement devices for repair whenever they are broken, because after repair it can show incorrect measurements’
(Nurse).*

The research showed that the repaired devices will be trusted if the biomedical engineer has a checklist or program provided by the manufacturer (Philips), which can help to analyze the quality of repair (workshop Nairobi). During the workshop the local biomedical engineer

described it is very important for him that the devices are easy to disassemble and he can easily indicate the different components. It should only be easy to disassemble the devices for the biomedical engineer. He suggested to use a special key to disassemble the devices, in this case only qualified engineers can disassemble the devices (biomedical engineer).

‘Smart error codes on the display of the devices make it easier to analyze the defects of the devices’ (biomedical engineer).

The most important aspect that can increase the reparability of the smart devices is display of smart error codes. Before a repairer can repair the devices it is important the repairer exactly knows what the defects of the devices are. Smart error codes are important to indicate what the defects are. Philips needs to develop a set of error codes, these error codes must be easy to analyze for the biomedical engineer.

These aspects are mostly preferred by public nurses and managers, because the public facilities have in-house biomedical engineers. For this reason repair instructions and tools are very important. The private facilities have no in-house biomedical engineer, which makes the repair instructions useless. The difference between private (average 4.0) and public facility (average 6.9) is showed in the graph ‘What can help to increase the opportunity for repair?’.

The field research showed the hypothesis is right, easy disassembling, construction drawings and coding of the components can improve the reparability of the smart measurement devices. Next to these aspects it is important that the quality of the smart devices can be checked after repair and that the smart devices included software that can indicate

what kind of defects the devices have. This means that Philips must develop a checklist (software) and smart error codes (software).

7.8.4 Conclusion

In this chapter the following aspects for repair are evaluated: local repair, online or mobile repair assistants and the reparability of the smart devices. Currently, local biomedical engineers can repair the broken health measurement devices, but they are not well trusted by the managers (in particular private managers). Philips can play an important role in improving the trust in the local biomedical engineers by providing training for the local biomedical engineers. Philips has to acknowledge the local biomedical engineer with a certificate or mark. Next to the local repair an online or mobile repair assistant can help to increase the opportunities for repair. It is important that the assistant is easy to contact and provided by Philips. Finally, easy disassembling, construction drawings and coding of the components will improve the reparability of the smart measurement devices. Next to these aspects it is important that the quality of the smart devices can be checked after repair and the smart devices include software for the indication of what kind of defects the devices have. This means that Philips must develop a checklist (software) and smart error codes (software).

7.9 Recycling

The last phase of the devices is the recycling of the devices, this phase is very important for the development of a circular business model. In this phase devices at the end-of-life can be used as raw materials for the manufacturing of new products. Currently, most of the products and devices are not recycled, but dumped on e-waste dumps or products are

stored. For this reason the recycling of the devices at the end-of-life is included in the business model for the smart screening and triage devices.

7.9.1 Local recycling

The recycling of the devices locally is very important for the development of a circular business model for the smart screening and triage devices. The local recycling increases the opportunities for a local sustainable business and reduces the emissions from the distribution of the defective devices. During the workshop in Eindhoven we focused on the local recycling of the devices, which led to the following hypothesis:

*‘Defective health measurement devices can be recycled locally’
(workshop Eindhoven).*

This hypothesis is evaluated during the field research in Kenya. An interview with a local recycling company, local repairer, local distributor and the workshop gave many new insight in how to improve the opportunities for the local recycling of the devices. Currently, the collected devices are disassembled and the components sorted locally. Most of the components are shipped to Europe for further recycling (Recycling manager). This will not change in the coming years, so it is not possible to completely recycle the devices in Kenya, but still we can improve the process to disassemble the devices.

*‘With e-Waste becoming a reality in Kenya and such recycling activities on the rise, a need is felt in all quarters for an efficient and environmentally sound management of e-Waste in the country. Across the world, mainly in Europe, there have been different models for the management of such waste, which have been successful’
(WEEE CENTRE, 2015).*

The interview with the local recycling company gave a lot of new insights, which need to be included in the development of the device and service around the devices.

First of all, a close relationship with local distributors and health facilities can increase the opportunities for collecting e-waste. The local distributor can collect the e-waste at the health facilities and then distribute the broken devices to the recycling company. Also a close relationship with the manufacturer (Philips) can help to improve the opportunities for recycling. The manufacturer needs to explain which components are included in the devices and how the devices can be recycled in an easy way (how to disassemble the devices and what kind of chemicals are in the devices).

Next to this, a sustainable design can help to recycle the devices in a more easy way; the recycling company prefers the use of ABS-plastics, no use of heavy metals, easy to disassemble design, rectangular displays and the possibility to disassemble the different colors of plastic. The recycling company has to pay for the recycling of batteries, therefore they prefer to use electricity instead of batteries (if that is not possible, rechargeable or lithium batteries are preferred).

Finally, the recycling company wants to receive instructions on how to clean the health measurement devices. The manufacturer must guarantee that the devices are safe to recycle (diseases). What is the best way for cleaning the devices?. Companies have to pay for the recycling of their devices: for the recycling of a laptops the local companies pay 250 Kenya Shillings and they receive a certificate after recycling (environmental responsibility).

These new insights gave a lot of aspects that need to be evaluated during the development of the design and business model for the smart screening and triage devices. The hypothesis is unjustified, because currently and in the future local recycling is not possible. The devices are only disassembled locally and Philips can improve the opportunities for disassembling the devices locally.

7.9.2 Conclusion

A close relationship with local distributors, health facilities and the manufacturer (Philips) will increase the opportunities for collecting and recycling e-waste. The manufacturer need to explain which components are included in the devices and how the devices can be recycled in an easy way. A sustainable design will help to recycle the devices in a more easy way. In this chapter some of the design aspects are described which will improve the opportunities for recycling. Next to the design aspects, the recycling company wants to receive instructions on how to clean the health measurement devices. The manufacturer must guarantee that the devices are safe to recycle (diseases). Companies have to pay for the recycling of their devices: for the recycling of a laptop the local companies pay 250 Kenya Shillings and they receive a certificate after recycling (environmental responsibility). The manufacturer (Philips) needs to educate the local companies to recycle the devices, because it is their environmental responsibility (show the effect of e-waste).

7.10 Workshop Nairobi

The field research in Kenya is evaluated and concluded during the workshop in the local Philips office in Nairobi. This workshop was organized in the last week of the research. The stakeholders who been interviewed during the field research were invited for the workshop, in specific the local distributor, private managers, clinical officer, biomedical engineer, recycling company and the medical officer. By inviting the various stakeholders it was possible to have a good discussion and make some conclusions which were acceptable for all the stakeholders.

During the workshop were six subjects discussed and evaluated, local repair, sustainable use, local sustainable business, recycling and reuse, sustainable design and data management. All these subjects were discussed during this workshop. For getting a clear overview of the different aspects post-its were used for making notes. These post-its are processed in a clear table on the next page. The results of the workshop were used in this chapter.

The subject 'data management' led to a long discussion with the participants. For all the participants data management is an important aspect and from the view of the participants there will be a big need for data management in the future. The subject 'recycling' shows the various stakeholders do not see the value of recycling their devices. The private managers mention their devices have always some value, in particular when they have to pay for the recycling of the devices. For the development of a circular business model it is important to motivate the health facilities to recycle their health measurement devices. The results of the workshop will be used for the development of the circular business model for the smart screening and triage devices, see chapter 8.



7.10.1 Results workshop

Data management
In-out flow smoother (value).
Sharing data among the health facilities.
Centralized decision support (-> flow to Philips).
Collect health information system, collaboration with health info-system companies.
Unified language/architecture for data collection, sharing utilizing (for intervention).
Input data: smart device, connected to smart phone (app. In device).
All data/measurement gets sent to a server (several parameters, continuous learning and improving the measurements).
Patient can collect his/her data from health facility (SD-card).
Offer better care to patients (incentive to share patient and measurement data).
Track (data) when battery is going down.
Patient privacy (law/gray area?), encryption of patient information.
Who uses/access the data? (patient; doc. confidential, Philips; research workflow and government; consensus epidemic management)
For who is the data interesting? (pharmaceutical companies, manufacturers, government and health facilities)
Government; to know why a country is plagued with a disease (investigate).
Unless all in digital format, how do we share?

Sustainable use
Theft? (disable display)
Remote disabling (informed staff of this), parts can still be resold.
Community that it won't be personally benefited (devices are important for the community health).
Identification no (unique).
Temporary ownership/responsibility to health workers (login personal password).
Manufacturer must inform the health workers how to use the devices in a good way.

Recycling/reuse
Education of CSR (Corporate Social Responsibility).
The display can be useable after the end-of-lifespan of the device (rectangular design is important).
Health facility use the recycling service without fee.
Health facility receive a certificate.
Disposability not in Kenyans mentality, use special key for repairer and recycling companies.
Prefer re-selling (instead of recycling).
Collecting from health facility to distributors.
GPS, trace where in repair or recycling process (health facilities want to follow their devices).
Health facility want to receive a fee, the components are valuable.

Sustainable design
Use re-usable components by repairer.
Electricity is preferred, but long-lasting batteries are also acceptable (rechargeable).
Commercial or specific Philips batteries? Commercial batteries are preferred (recycling and availability).
If the Philips batteries have a better lifespan, efficiency and are rechargeable then are these preferred.
Protective sleeve (protect the devices against poor use).
Robustness is important, think about the ambulance services (protective sleeve can help).
Customizable (ambulance, private and public facilities); hardware and software (upgradeability) .
Make it easy for in-house engineer to fix the devices (error codes, detect and indicates defects).
Rechargeable battery (10 hours), power or solar.
Solar panel depending on where its used (in-house or in-field).

Local repair
Connect device to phone to remote repair.
Call who? (Bio-medical engineer)
Remote repair/screening.
Ownership of the devices?
Error codes to repair, especially for digital devices.
Helpline (troubleshoot).
The repairer must receive a training from the manufacturer.
Health facilities trust only a repairer with a certificate from the manufacturer.
Quality check after repair; software and hardware (program).
Warranty, health facilities are willing to pay more.
Cost of repairer, local better than by manufacturer.
Quick and easy to repair devices.
When broken recycling or repair? (digital check about status of the device)

Sustainable business
Warrantee price in the package price (purchase price).
Public(ministry)/private? (who buys the device, private facilities invest more in new devices)
Private facilities are more flexible in buying new devices (public -> difficult protocols).
Data can provide a sustainable business for Philips and local M-health companies.
Efficiency is more value to health facilities (providers health).
Personal health record -> value for patients (better quality of healthcare/service).
The level 4/5 hospitals and private facilities have almost all a digital patient information system, the challenge is to synchrony these systems.
The prices of the private health facilities will increase of the better service (but quality of healthcare will also increase).

7.10.2 Conclusion

The (digital) collection of patient and measurement data is an important topic in the Kenya health sector. Currently, a lot of private facilities and higher level public hospitals collect digital data. During the workshop was concluded this data can help to improve the patient flow and the consultation time, when previous data can be used by the next facility. The sharing of patient data is accepted by all the stakeholders, but it is important this data cannot be linked directly to the patients. The use of codes are essential. Next to the facilities the data can be sold to pharmaceutical companies, manufacturers and the government. The health measurement devices are currently not used well by the health workers, education and instructions for good use can expand the lifespan and efficiency of the devices. Next to this is the theft of the devices an important aspect to include. Health facilities are currently not recycling their devices, because in the Kenyan context the devices have always some value. For this reason it is important to motivate the health facilities to recycle their devices. The devices are important for providing good health services, therefore is the lifespan of the devices important. The stakeholders prefer to have a robust device which is still easily to disable. During the workshop the stakeholders preferred a robust sleeve for the devices. Next to the recycling of the devices is the repair of the devices an important aspect for the development of a circular business model. During the workshop was concluded the health facilities want to repair their devices locally, but only when the local biomedical engineer received a training and certificate from the manufacturer (Philips). The use of the health measurement devices will make it possible for the health facilities to provide better healthcare and this will led to an increase in the revenues for the health facilities, in particular the private facilities.

7.11 Conclusion

Distribution	Payment	Service
Closer relationship with the local distributor is needed.	Pay in-one-go (purchase device).	Intensive aftersales services (competitive advantage).
Training and education (on how the devices work).	Pay each year (service contract).	Training provided by Philips (Health workers).
Quality check (share of the devices).	Private sector (pilot market).	Traceability and disabling (reduce theft).
Datamanagement	Repair	Recycling
Need for digital patient and measurement data	Certificate or mark (qualified local distributors).	Improve opportunities for disassemble the devices locally.
Use previous data (CHW) for comparison of new data.	Online/mobile repair assistant (provided by Philips).	Sustainable design for recycling (ABS-plastic, rectangular displays).
Sharing patient data (facilities, government and Philips).	Checklist and smart error codes (reparability).	Instructions for safely cleaning (patient contact devices).



8. Final Business model

In the previous chapters are the requirements (circular aspects) and opportunities (workshop results and brainstorm sessions) for a circular business model described, these aspects will be used for the development of the final circular business model for the screening and triage devices. In this chapter the advice for the final circular business model is described in more detail. In this chapter advised circular business model is not the only possible version for the business model, there are many other opportunities for combining the different aspects which are described in the previous chapters for the development of the circular business model.

8.1 Business model canvas

In this chapter will the Business Model Canvas be used for the development and explanation of the circular business model for the screening and triage devices (advice). The Business Model Canvas consist of the following elements: key partners, key activities, key resources, cost structure, value proposition, customer relationships, channels, customer segments and the revenue streams. Each of those elements will be described more in detail and will be linked to the circular business model for the smart screening and triage devices.

8.2 Key partners

The introduction of a new business model on the market, in particular a circular business model, can be difficult. For this reason it is important to develop a sustainable relationship with the partners and suppliers, because they are important for the success of the business model. The manufacturer (Philips) is dependent of the provided services by the partners and suppliers, for this reason it is important for Philips to

develop a sustainable relationship with the stakeholders and invest in strategic alliances between non-competitors.

8.2.1 Distributor

A local distributors (chapter 7.3.1) will be used for the distribution of the smart screening and triage devices to the health facilities. The use of a local distributor has a positive effect on the circularity of the business model, because of the power of the inner circle (chapter 5.2.1) by making the circle smaller. Philips needs to develop a close relationship with the local distributor, this has a positive effect on the partnership and service provided by the local distributor.

8.2.2 Repairer

A local repairer (chapter 7.8.1 and 5.1.3) will be used for repairing the broken smart screening and triage devices. The use of a local repairer has a positive effect on the maintenance and repair (chapter 5.3.1) opportunities. This will increase the power of circling longer (chapter 5.2.2) and the lifespan of the devices. Philips needs to provide the local repairer the right education and certificate for repairing the devices in a good way.

8.2.3 The government

The government is an important partner for the introduction of the smart screening and triage devices. It is important the government trust and sees the added value of the devices, because then the government allow the public health facilities to use the devices. The measurement and patient data (chapter 7.6.4) can be sold to the government (epidemic management policy). Philips will provide the access to this data (chapter 5.1.4). The selling of the data can provide a sustainable financial flow.

8.2.4 Recycling company

The recycling (chapter 5.3.4) of the smart screening and triage devices is an important aspect for the realization of a circular business model. The smart devices has to be reused or the components recycled at the end-of-lifespan (chapter 5.2.4). Philips needs to provide the right local infrastructure (collaboration between repairer, distributor and recycling company) and design for recycling the devices. It is important to be aware of the requirements from the recycling company and health facilities (chapter 7.9.1). Philips has to motivate the (incentive) health facilities to recycle their devices, this can be a points-system (health facility receive discount by hundred points) or a certificate. The local recycling company in Kenya, WEEE Center, can be a good partner.

8.2.5 Non-governmental organizations

It is important to include the non-governmental organizations (Red Cross and The Flying Doctors) and the churches (chapter 6.4.3) in the business model, these organizations can motivate (chapter 7.7) the patients to go for a health check. This will improve the patient flow in the health facilities and by this the added value from the smart devices will be more appreciated. Next to this NGO's and churches can promote the smart devices to the patients, with this the patients will ask for the devices by the health facilities. This give the health facility (in particular the private health facilities) an impulse for buying the devices.

8.2.6 Decision support

The smart health measurement devices increase the efficiency of the workflow of the health workers by fast and easily collecting measurement data from the patients (chapter 6.4). Next to collecting the data it is interesting for Philips to develop a platform which can provide decision support to the health workers.

8.2.7 Data management

In the coming years will data management (chapter 7.6) be an important aspect in the health sector. It can be interesting for Philips (chapter 6.4.3) to provide the infrastructure and resources (smart devices) for collecting and sending the patient and measurement data. Philips can develop this data platform, but in the beginning Philips can start a collaboration with a well-known local data company (for example: M-health).

8.3 Key activities

The key activities focusses on the activities which are the most important things the company must do to make the business model work and for making it sustainable. The key activities are divided in production, problem solving, and supply chain management.

8.3.1 Production

The smart screening and triage devices will not be produced in Africa, the main reason is the economics of scale. The production process of the devices need to be efficient as possible. The residual materials of the production process (power of the inner circle, chapter 5.2.1) need to be reused for the production of other products. It is important to analyze the production process before Philips develops the final design for the devices. This will increase the opportunities for designing the devices in such a way it can increase the efficiency of the production process.

8.3.2 Problem solving

The shortage of the availability of well-educated health workers (chapter 3.1.4) is one of the reasons for the poor healthcare services in emerging countries. According to recent research of WHO, it is estimated the current workforce in some of the most affected countries in Africa would

need to be scaled up by as much as 140% to meet international health development targets. For this reason are new systems, processes and devices needed. Philips wants to solve some of the problems by developing a smart device (chapter 3.3.1).

The development of smart devices is not enough and not sufficient without good aftersales services and optimal use of the devices. For this reason Philips has an important role in consulting and engineering of the smart devices and the service around the devices. There are a few aspects which need to be included, the development of an online/mobile repair assistant, engineering of good repairable/recyclable devices, developing a training/education service, and consult the health facilities on how to use the devices.

Consult local repairer on how to improve their reputation and on how to repair the devices in a good way. Philips needs to guarantee the quality of the repaired devices from the local repairer, by giving the local repairer a certificate when they succeed the 'Philips repair training' (chapter 7.8.1). Next to the repair is the theft of the devices an important aspect for the sustainable use of the devices. Philips needs to consult the health facilities and manufacture a GPS and disabling system (chapter 7.5.3) for reducing the theft of the devices.

8.3.3 Supply chain management

The supply chain of the smart screening and triage devices is an important aspect for the success and sustainability of the circular business model. By analyzing the supply chain management Philips will increase the opportunities for a circular business model. The smart devices need to be transported in boxes, these boxes will make it easier to transport and protect the devices. Normally these boxes will be waste when the devices

are delivered by the consumer, but in this circular business model these packets (boxes) will be reused. The local distributor will use the boxes to distribute the devices to the client and after delivering the distributor will use the boxes for collecting the old devices. These old devices can be brought to a local repairer or recycling company (power of cascaded use, chapter 5.2.3). Next to this can Philips add another functionality to the boxes, Philips can add the instructions (how to install and use the devices) on the boxes (transform the box in an instruction poster).

To reduce the distribution of the different elements of the device it is efficient to manufacture the different aspects in the same factory (power of the inner circle, chapter 5.2.1). The manufacturing of the labels, instructions, boxes (package) and the devices in the same factory will reduce the financial and environmental costs of the production process. Finally, the distribution process need to be efficient as possible, the smart devices need to be designed in such a way it can be distributed and stacked easily.

8.4 Key resources

The key activities can only be provided with the right key activities, for this reason it is important for Philips to be aware of having and collecting the right key resources. Currently, Philips is based in Nairobi, this local office can play an important role for starting a pilot project for the smart screening and triage devices. It is important for Philips to employ the right people. For the development of this circular business model are employees needed which can develop a sustainable relationship with the local repairer, distributor, health facilities, and recycling company. Train project leaders to education and train the local partners on how to use, repair, recycle and upgrade the devices.

8.5 Cost structure

There are two kind of costs structures, the fixed costs and variable costs. For the development of a circular business model it is important to have a sustainable financial flow (more revenues than costs). The fixed costs are insurance, interest expense, rent (factory and other buildings), salaries (employees), utilities, property taxes, depreciation and amortization (accountingtools, 2015). The variable costs are production supplies, distribution, materials (smart devices), commissions (for local distributors) and piece rate labor (accountingtools, 2015). It is important to be aware of these costs and manage to sustain the financial flow for all the stakeholders. The production, distribution, consulting, training and the costs for the aftersales services are the highest for the smart screening and triage devices.

8.6 Value proposition

Philips wants to help the Kenyan government to meet international health development targets (chapter 3.1.4), by tackling the problem of the shortage of the availability of well-educated health workers. Philips develops a smart screening and triage device which will help the health workers to collect faster and more accurate patient and measurement data, the smart devices will increase the efficiency of the workflow (chapter 3.3.1). The health facility and the government are the customer in this circular business model. There are many stakeholders which are included, for example the patients and health workers. Next to faster and more accurate health measurement devices it will be possible to sharing data and decision support when needed, this makes it possible for less trained health workers to screen and triage patients in an accurate way. With this the smart devices makes it possible for the health facilities to

consult more patients each day and in a reliable way. The Philips smart devices will be of good quality with a long lifespan. Next to the good quality of the smart devices will Philips deliver customer-focused after sales services. The service consists of maintenance and repair assistance (chapter 7.8.1), training and education (chapter 7.5.2), decision support, data management, and guarantee. These aftersales services will extend the lifespan (chapter 5.2.2) of the devices and the efficiency of use. By delivering smart devices with customer-focused services Philips will help the government (epidemic management policy) and the health facilities to improve the quality of healthcare in Kenya.

8.7 Customer relationships

By providing good quality devices and customer-focused aftersales services Philips develops a good relationship with the customers (health facilities and government). But for the development of a circular business model and a long-term relationship it is necessary to have a closer relationship with the customer. Philips will provide this closer relationship with the customers by working with local distributors and repairer who are well-known in the community, the mobile repairer assistant (chapter 7.8.2) makes it possible for the customers to call somebody when needed.

8.8 Channels

The stakeholders who are described in the 'Key partners' will be used for informing the customers about the new devices and services. The local distributor for informing about the new devices, the local repairer for informing about the maintenance (updates) service and the NGO's or

churches for motivating and informing the patients about the functionality and use of the smart health measurement devices.

8.9 Customer segments

The circular business model focusses on the health facilities in Kenya, the system which is used in this model can be adapted for the private and public healthcare market. The new health measurement devices will be introduced in the private healthcare market, because it is easier to start in this market (chapter 7.4.4). When the smart devices prove their quality and are upgraded to meet the latest preferences it can be introduced in the public healthcare market. The data which will be collected with the smart devices can be used by the government for their epidemic management policy (chapter 7.6.4). The focus will be mainly on the national government, for this reason the national government will be the customer to who Philips can sell the collected patient data. At the end-of-lifespan the devices and components can be sold to a secondhand market (chapter 5.2.3). This market can use the devices or components for other purposes. Philips will work close together with local shops and recycling companies to make this possible, for example the good working battery of the devices can be used for recharging other devices (mobile phone).

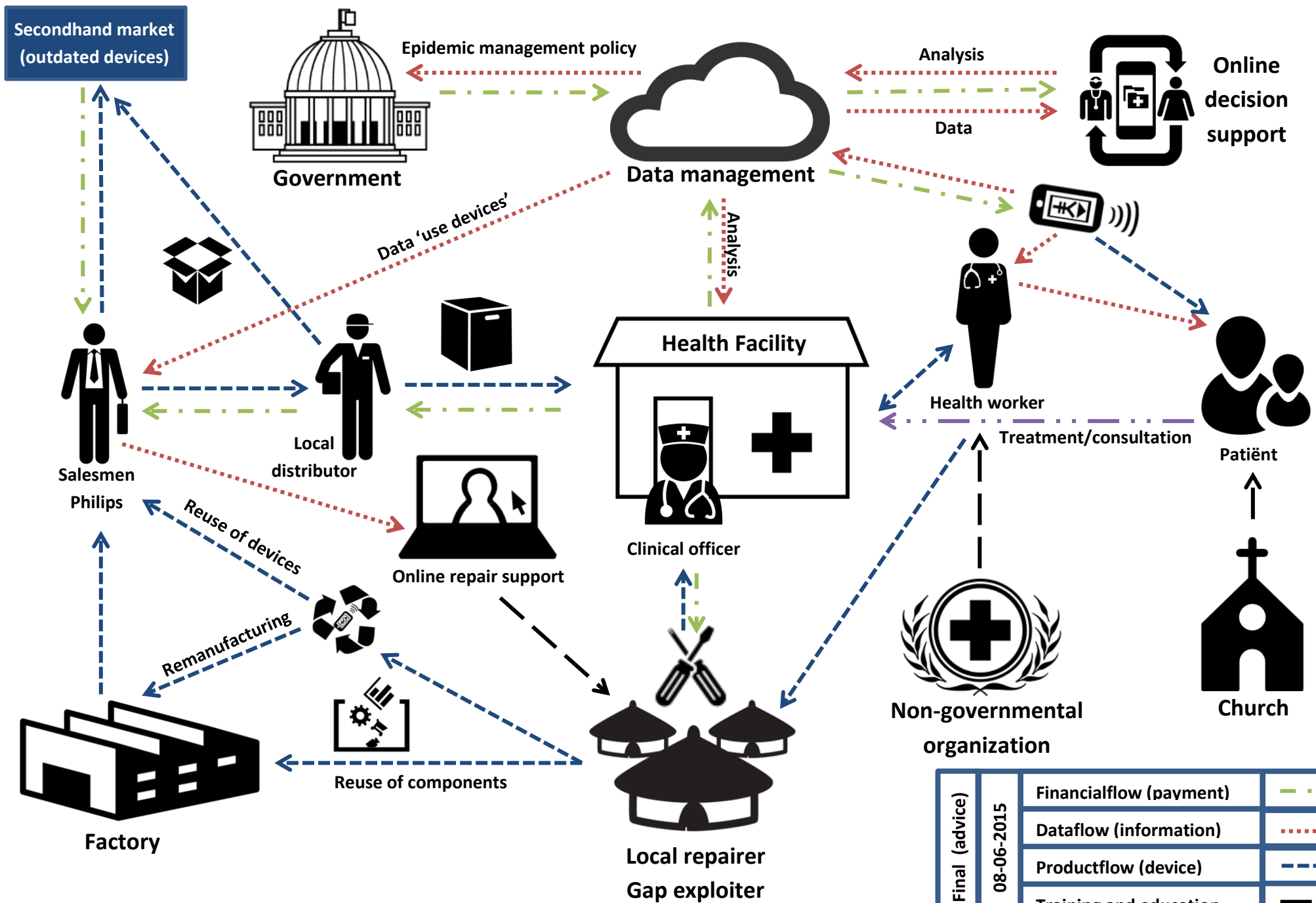
8.10 Revenue streams

It is essential for the circular business model to have a sustainable financial flow, in this case there are more than one revenue streams. The health facilities will purchase the devices in-one-go (chapter 7.4.1). This provides an only-one time revenue stream, this will not help to sustain the circular business model. For this reason are periodic revenue streams needed, the health facilities will pay a yearly fee (chapter 7.8.2) for the

maintenance and repair service (mobile assistant and warrantee). Next to the purchase of the devices and the service fee (in the future) it will be possible to provide a revenue stream with collecting and analyzing patient and measurement data. This data can be sold to the health facilities or the government for epidemic management policy (chapter 7.6.4). Currently, it is not possible to collect and sell the data, because the infrastructure is not there, but this will change in the coming years.

8.11 Conclusion

In this chapter are the Business Model Canvas elements described of the circular business model for the smart screening and triage devices, in particular for the Kenyan healthcare context. Each element includes some aspects which contribute to the circular business model. The aspects focusses on a sustainable and long-term business model for the manufacturer (Philips), stakeholders, and customers. On the next page is the circular business model for the smart health measurement devices visualized. Finally, is the Business Model Canvas template used for providing a clear overview of the different elements which are included in the circular business model.



Key partners	Key activities	Value proposition	Customer relationships	Customer segments
1) Local distributor (Medical24) can help Philips to deliver the products (devices) to the health facilities. 2) Local repairer (private biomedical engineer) will be used for repairing the broken smart devices. 3) The government can use the patient data for their epidemic management policy. 4) Recycling company (WEEE Center) can help to recycle the devices at the end-of-lifespan. 5) World Health Partners can help to analyze the collected patient data. 6) M-Health can help to collect the patient and measurement data. 7) Flying doctors/Red Cross can help to train the Health Workers how to use the devices in a good way. 8) The church can help to inform (promote) patients to go for a screening or triage.	1) Production: producing the smart health measurement devices in a sustainable way. 2) Problem solving: providing a solution for the health service, repair opportunities, and reducing the theft in Kenya. 3) Supply chain management distribute the devices in a sustainable way (efficiency).	1) Philips will develop a smart screening and triage device which will help the health workers to collect faster and more accurate patient and measurement data. With this Philips wants to tackle the problem of the shortage of well-educated health workers. 2) Philips will develop a platform which will provide the infrastructure for data sharing and decision support. This makes it possible for less trained health workers to screen and triage more patients in an reliable way. 3) Philips will provide customer-focused aftersales services: the service consists of maintenance/repair assistance, training/education, decision support, data management, and guarantee. These after sales services will extend the lifespan of the devices and the efficiency of use. 4) Philips will develop a platform for improving the repair and recycling of the smart health measurement devices, with this Philips meets their environmental responsibility.	1) Philips will provide good quality devices and customer-focused aftersales services, this will lead to a good relationship with the customers. 2) Philips will develop a local platform with local distributors and repairers who are well-known in the community (sustainable relationship).	1) Philips focus on the health sector in Kenya. This model can be adapted for the private and public healthcare market. 2) Philips can start with the introduction of the smart health measurement devices in the private healthcare market. 3) Philips will introduce the smart devices in the public healthcare market when the smart devices prove their quality and are upgraded to meet the latest preferences. 4) The national government use the patient and measurement data for epidemic management policy. Philips will ask a fee for the data management. 5) Philips will develop a platform for selling and buying the outdated health measurement devices to a secondhand market (circular).
	Key resources 1) A local office that can help to sustain the relationship with the key partners. 2) Excellent technology, design opportunities which are needed for the development of the devices. 3) Customer-focused employees who can help to educated and train the key partners. 4) Sustainable production process that can produce the devices in a sustainable way.		Channels 1) Local distributor (Medical24) can help Philips to deliver the products (devices) to the health facilities. 2) M-Health can help to collect the patient and measurement data. 3) World Health Partners can help to analyze the collected patient data. 4) The church can help to inform (promote) patients to go for a screening or triage.	
Cost structure The fixed costs; insurance, interest expense, rent, salaries, utilities and property taxes. The variable costs; for the developing of the smart health measurement devices, online assistant, distribution, education and training.			Revenue streams The Health facilities purchase the devices in-one-go and pay a yearly fee for the aftersales services. In the future it will be possible for Philips to distribute their data to other institutions or organizations, Philips will receives a fee for this data .	

9. Conclusion

Smart healthcare devices are important for improving patient care in developing countries. These devices can help the less-trained health workers to collect reliable patient measurements and improve the workflow in the health facilities. It is envisioned that smart devices will contribute in solving the shortage of well-educated health workers in the developing countries. This will increase the quality of healthcare in those countries. Philips can help the Kenyan government to achieve their healthcare targets by creating healthcare solutions.

This research aims to gain a better understanding of the needs and preferences of healthcare workers and facilities regarding the use, implementation, and maintenance of such devices. The main focus during the research was on the circular elements and service around the devices. The results of the research have led to the development of a circular business model. During the research the focus was on the following aspects: **distribution, payment, service, training and education, theft, data management, motivating patients, repair, and recycling**. This research led to many new insights which are described in this report.

Firstly, the **distribution** of the smart healthcare devices can be done by local distributors, but Philips needs to include some measures: educate/train local distributors on how to install and on how the smart health measurement devices work. This means Philips needs to develop a close relationship with the local distributors, which is not yet the case.

The research shows less preference for leasing contracts (**payment**) by the local health facilities (in particular the private health facilities). Therefore it is not possible to use leasing contracts for the development of a long-term relationship with the different stakeholders. The local health facilities (in particular private health facilities) prefer to purchase the devices in-one-go and to pay a yearly fee for the service contracts.

Instead of using leasing contracts Philips can develop a competitive advantage (long-term relationship) by providing customer-focused

after-sales services (training, repair, installment and updates), because there is a great need for more service in the Kenyan health sector. Currently, the services provided by Philips are not customer-focused at all, for this reason there are many opportunities for improving the after-sales services.

Next to this, the research shows that the local distributors and health workers are not always well informed about the installation and use of the devices. For this reason it is not possible for the stakeholders/partners to provide intensive services to the customers. The field research shows the importance of **educating and training** the local partners. Philips can provide the training themselves, but Philips could also work closely together with non-governmental organizations on improving the good use and the lifespan of the devices. In collaboration with NGO's Philips can train/educate health workers and local distributors on how to install and on how to use the smart devices.

Besides the good use of the devices, the possible **theft** of the devices is an important aspect, because a lot of health measurement devices are stolen by the health workers in the African context. The results of the questionnaire show that Philips can reduce the theft of the smart devices by developing a traceability and disabling system. By reducing the theft the devices will be used by the right health workers and for the right purposes.

The (the digital) collection of patient and measurement data (**data management**) is an important topic in the Kenyan health sector. A lot of private facilities and higher level public hospitals are already collecting digital data. When previous data can be used by the next facility it is possible to improve the patient flow and the consultation time, because the previous measurement and patient data can be used instead of screening the patient again. The sharing of patient data is accepted by all the stakeholders, but it is important this data cannot be linked directly to the patients. For this reason de-identification of the data is essential. The

workshop in Nairobi shows that next to the facilities, the data can be sold to pharmaceuticals, manufacturers, and the government. This future need (data management) is an important aspect for the sustainability (reduction of paper use) of the business model. In the longer run Philips needs to include the data-management in the circular business model.

Although it is important to have the enablers such as delivering a good service and the right devices in place, it is of vital importance that the patients comes to the facilities for a health check. For this reason **informing and motivating patients** is an important aspect of the development of a circular business model for the smart healthcare devices. Before patients will accept the devices and see the benefits of the device they need to be informed about the necessity of being screened. Next to informing it is necessary to motivate the patients to go for a health check by a health facility or CHW. The results show that the church, NGO's, and the government have a crucial role in motivating and informing the patients.

As well as the good use of the devices, the **repair** of the devices is an important aspect for the development of a circular business model. In the African context, local biomedical engineers can repair broken health measurement devices, but they are not well trusted by the facility managers (in particular private managers). The results of the questionnaire show Philips can play an important role in improving the trust in the local biomedical engineers by providing training for the local biomedical engineers. Philips has to acknowledge the local biomedical engineer with a certificate or mark, because this will increase the trust in the local biomedical engineers. Next to the local repair, the primary health facilities prefer to contact a Philips employee for asking questions about the quality of the devices, the field research shows the preference for an online or mobile assistant.

Finally, the **recycling** process is an important aspect for the development of the circular business model. It is Philips environmental responsibility to

reduce the e-waste flow of their products. For this reason it has to improve the opportunities for the recycling or reuse of the smart devices. A close relationship with local distributors and health facilities will increase the opportunities for collecting and recycling e-waste, because the stakeholders need to be informed about the opportunities and benefits of recycling the devices. The local recycling companies need to know which components are included in the devices and how the devices can be recycled in an easy way. It is Philips responsibility to provide the right instructions and information to the local recycling companies and a more sustainable design (easy to disassemble) will increase the recycling opportunities. The field research shows that the recycling companies want to receive instructions on how to clean the health measurement devices, a guarantee that the devices are safe to recycle, and needs to educate the local companies on how to recycle the devices. These aspects will reduce the amount of e-waste at the end-of-lifespan of the devices. This will also improve the relationship with the local government, because they are now dealing with the increasing amount of e-waste.

The research and final business model show Philips needs to develop smart devices with customer-focused aftersales services. This all means Philips needs to focus more on the services around the devices, instead of only focusing on developing and selling of good quality products (traditional linear consumption pattern). For the realization of a circular business model it is important to evaluate all the stages of the smart devices and improve the opportunities for extending the lifespan of the devices in each stage. In this case Philips needs to provide and develop the infrastructure for optimal maintaining, repairing, reusing and recycling of the devices. To meet future needs and sustain the circular business model it is important to analyze the opportunities for developing a **quality check, local training/education, traceability and disabling system, mobile assistant, providing decision support and add recycling aspects** in the design of the devices. Those new insights and opportunities led to short- and long-term recommendations which are described in the next chapter.

10. Recommendations

I completed my graduation research with pleasure at Philips Design. I have gained a lot of new knowledge and experiences which I'm sure will apply in the future. The research has given me many new insights, I would like to share these insights in this chapter'

Maurice van den Oever

10.1 Short-term recommendations

1. A mobile (or online) repair assistant needs to be provided by Philips, which will increase the opportunities for repair and improve the relationship with the customers. I would recommend Philips to develop this mobile platform before introducing the smart devices on the market.

‘Currently, Philips research (Govindarajan, Karthik) is developing a Skype assistant who can assist the local partners. Perhaps this feature can be used for the African healthcare market, in specific for the smart screening and triage devices’ (Venture manager healthcare).

2. Local education and training needs to be provided by Philips for the local partners. This will help them to use and install the devices in an optimal way. The education and training can be given by the local Philips employees. Currently, many of these trainings are in Europe and it is not possible for all the local partners to travel to Europe.

‘For most of the local partners, it is difficult to travel to Europe for training. This makes it difficult to train the local partners, because it can be expensive to provide trainings in all the countries over the world. However, Philips has already developed an E-learning platform which can be used for the smart devices’ (Venture manager healthcare).

3. E-waste is a big problem in Africa. It is Philips’ environmental responsibility to reduce the amount of e-waste of their products. For this reason it is important for Philips to include the recycling and dismantling process in the design and business model of the smart screening and triage devices. The following aspects need to be included: a close relationship with local stakeholders, a list with included components (which chemicals are in the device), an easy

to disassemble design (but with protective sleeve), use of ABS-plastics, no use of heavy metals, rectangular displays, enable disassembling the different colors of plastics, use rechargeable batteries, and instructions on how to clean the health measurement devices.

‘Of course, Philips has an environmental responsibility and for this reason Philips has to include the repair, recycling and production aspects. But still we need to sell the devices for a good price and with good quality. Sometimes it is necessary to use less recyclable and repairable devices. People are not always willing to pay more for sustainable devices, certainly not in Africa’ (Venture manager healthcare).

4. Next to reducing the amount of e-waste of the products at the end-of-lifespan, it is important to reduce the material and energy flow during the production process of the products. For this reason, it is important to include the production process in the design of the products. Philips needs to design the products in such a way that they don’t require too much energy and materials during the production process. I recommend Philips to employ a design expert who focusses only on making the production process of the products more efficient. This does not have to mean that the design made by this employee will be the final design for the product, because there are many other requirements for the design of the products (easy-of-use, costs, and functionality). But creating a design concept which focusses only on making the production process more efficient will start a discussion during the workshops about the production process. With this discussion some of the production design aspects can be included.

5. In the beginning of the research (in particular during the first workshop) the focus was mainly on the public healthcare market. This focus was mainly because of Philips longer-term goals to increase the level of healthcare in Africa, in specific Kenya. During the research process it was concluded that the private healthcare market is more interesting to focus on in the short term, because of the flexible budgets, less official requirements, and the need for smart health measurement devices. Philips can prove the value of the devices within the private healthcare market and use the experience of the private facilities to introduce the devices in the public healthcare market. For this reason, Philips needs to focus on the private healthcare market in the short term.

‘This sounds logical, because the private healthcare market is more (or easier) accessible than the public healthcare market. The private healthcare market can be a test lab for the devices. Before entering the public market Philips can use the feedback from the private market to improve the devices’ (Venture manager healthcare).

6. The theft of health measurement devices is a big problem in the African context. Philips can help the local health facilities to reduce the theft of their devices by adding additional features to the devices. Philips needs to develop a platform which can track (GPS) and disable the devices. This will reduce the incentives for stealing the smart health measurement devices.

‘This system will be helpful for the African, in specific Kenyan, context. The tracking (GPS) and disabling system can be linked to other partners. Philips can work closely together with local banks, internet and mobile phone providers for reducing the theft of the devices. When a device is stolen Philips can ask the mobile company to block their account’ (Venture manager healthcare).

7. Next to the education and training provided by local Philips employees can the development of an E-learning platform help health workers, managers, local repairers, local distributors, and recyclers to learn how to install, use, repair and recycle the smart health measurement devices. For this reason, Philips needs to develop an E-learning platform. It must be valuable and meaningful for the stakeholders to do the E-learning process. Rewarding the stakeholders is an important aspect for the success of an E-learning program. After successfully completing the E-learning program Philips will reward the stakeholder with a certificate or mark.

‘Philips has already developed an E-learning platform which can be used for the smart devices, but in this E-learning platform the rewarding of the stakeholders is not included. This needs to be added, if it is necessary’ (Venture manager healthcare).

8. During the desk-research and workshop in Eindhoven the non-governmental organization Flying Doctors was mentioned a lot, but during the field research I noticed this organization is not well-known in the Kenyan context. All the stakeholders, in specific the health workers, work closely together with the Red Cross. For this reason, I recommend Philips to work closer together with the Red Cross instead of the Flying Doctors. Next to the Red Cross the Bill&Melinda Gates Foundation can be an interesting organization to work with, especially when Philips focusses on the private healthcare sector. The Bill&Melinda Gates Foundation focusses specifically on the private sector. In conclusion, I recommend Philips to work closely together with the Red Cross in the public sector and with the Bill&Melinda Gates Foundation in the private sector.

‘That’s right the Bill&Melinda Gates Foundation can be an interesting organization when Philips focusses on the private health sector in Kenya’ (Venture manager healthcare).

10.2 Long-term recommendations

1. The shortage of well-educated health workers is a problem in African countries, in specific Kenya. For this reason, I would recommend Philips to develop a decision support platform. This platform can help the health workers to make reliable decisions. The best way for developing this platform is to work closely together with local health technology companies (World Health Partners) and health facilities.

‘Decision support can be an interesting element to include in the smart devices, but there are many elements which have an impact on making the right decision with the collected measurements (reliability of the measurements collected by health workers). In India Philips monitors 800 hospital beds on the Intensive Care department, so there are certainly opportunities for more decision support’ (Venture manager healthcare).

2. The sharing of the smart devices can help to increase the amount of screened patients. This will improve the quality of healthcare in Africa, in specific Kenya. Philips needs to provide the right infrastructure and opportunities for sharing the smart devices. Philips needs to develop a quality check (the quality check will help managers to check the status of the devices after sharing) and a platform for sharing the devices (this platform must provide a clear overview of the health facilities in an area which have smart health measurement devices).

‘Currently, Philips has developed a quality check for the ultra sounds. This quality check works with a LAN-connection, so it is possible to do a diagnosis and updates from a distance. Maybe it is possible to use this quality check for the smart screening and triage devices. (Venture manager healthcare).

3. To meet future needs it is important to include the options for sharing and receiving data in the smart health measurement devices. Currently, the higher (level 3, 4, and 5) level hospitals and the private facilities use digital patient and measurement data. In the coming years the need for more data will increase.

‘Data management is booming in Africa, but with the current infrastructure it is not possible to send patient and measurement data everywhere. In the coming years this will change’ (Venture manager healthcare).

4. Currently, there is a lot of knowledge about the African healthcare market and the need for smart health measurement devices. Instead of doing more research about this market, I want to recommend Philips to analyze the data which is already collected and available. With this data Philips can develop a good concept version for a smart screening and triage device. When this device is in a further stage Philips can analyze and improve the concept within the local context. During this research and the development of the concept version it is important to work closely together with the local Philips office in Africa and Philips research. The relationship between research and design can be improved when both departments are involved from the beginning of a project. Nowadays, there are a lot of projects in both departments which can be combined between the both departments.

‘It is not always possible to work closely together with both departments in each project, but there are many projects where Philips Design and Philips Research work closely together in a project’ (Venture manager healthcare).

10.3 Implementing recommendations

The research led to many new insights for the development of a circular business model for the smart health measurement devices. These new insights and my own vision led to the formulation of the recommendations. In this (sub-) chapter the recommendations are described with which Philips needs to start.

10.3.1 Customer-focused aftersales services

I recommend Philips to start with appointing or employing a project leader or advisor who will focus on the development of customer-focused services around the devices and include the different kinds of circular aspects.

10.3.2 Design instructions

After implementing 10.3.1, Philips needs to develop instructions (books, posters or videos) on how to design a product in such a way that it is easy to maintain, repair or recycle. In these instructions the different kind of circular business model aspects are visualized.

10.3.3 E-learning platform

In the third stage I recommend Philips to develop an E-learning platform. This can help to train the local partners on how to install, use, repair, maintain and recycle the devices in a good way.

10.3.4 Mobile (or online) repair assistant

Finally, I recommend Philips to develop a mobile (or online) repair assistant. The assistant can improve the opportunities for repair and improves the relationship with the local stakeholders. The assistant is mobile (or online) and therefore also easy to implement in different counties and areas.

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Annex - Questionnaire