

Bachelor Thesis Assignment

Improving the sustainability of waste streams at the Heart Center of Isala Hospital in Zwolle

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Zwolle

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Preface

This research is performed as a final assignment before finishing the Bachelor of Health Sciences at the University of Twente. The research has been conducted at Isala hospital located in Zwolle from February to June 2022. During this research, I was working in the procurement department of Isala and focused my thesis on the Heart Center.

In this preface, I would like to take the opportunity to thank some people. Firstly, I would like to thank my external supervisor, Jacqueline Bosker. She has been very supportive and always had valuable input for my research. Jacqueline offered me a lot of possibilities and granted me the freedom to choose my subject. Jacqueline Bosker was part of ZIN (Zorg Instituut Nederland). ZIN consists of experienced people from Isala and other hospitals. Therefore, I would like to thank every member of ZIN for their involvement during my research. Every member of ZIN was very helpful. I would also like to thank every colleague in the procurement department and the colleagues that I have spoken with at the Heart Center. It was very nice to get some practical experience during my research.

Of course, I thank both my supervisors of the University of Twente, Patricia Rogetzer and Erwin Hans. Both supervisors were very enthusiastic and helped me through the entire process. In the beginning, Erwin Hans was helping me with choosing a specialisation in the field of sustainability. He always sent interesting input and was always available for questions. Patricia helped me during the process with good feedback. She kept me motivated and always answered my questions very well.

Lastly, I thank my friends and family for their support during this period. Everyone showed a lot of interest which kept me motivated to finish this thesis.

Enjoy reading this thesis!

Delphi den Riet
July 2022

Management summary

Sustainability in hospitals is an increasingly hot topic. At least 7% of the CO₂ emissions have been caused by the healthcare sector. Currently, sustainability in the healthcare sector is still little or not taken up. However, the healthcare sector can make a large contribution to CO₂ reductions. These reductions can help to reverse climate change and have a positive effect on public health. This potential contribution has been noticed by Isala, which signed the Green Deal in 2019 to reduce its own CO₂ emissions and promote the benefits and importance of a circular economy.

Problem definition

The research context is Isala's Heart Center, where the surgical procedures are performed in the heart catheterisation rooms (HCKs). The Heart Center is a fairly new player in the field of sustainability, and hopes to reduce its large waste streams. There is currently a lack of knowledge at the Heart Center, on methods to establish more sustainable waste streams. Hence, this research aims to provide insights into sustainable initiatives from different perspectives that contribute to sustainability and waste reduction at the Heart Center. This research goal can be translated into the following research question:

"To what extent can the waste streams at the HCKs of Isala's Heart Center in Zwolle be made more sustainable?"

Approach

To outline the current situation, the waste streams at the HCKs of Isala have been observed and identified. After identifying the current situation, waste management initiatives are investigated through literature and interviews. Literature research offers insights into sustainable waste management strategies. Additionally, nine interviews have been conducted with Isala's Green teams, other hospitals, and organisations that are active in the healthcare sector and focus on sustainability. After gathering data about sustainable initiatives, a literature study about KPIs (Key performance indicators) is performed. Finally, the gathered information is analysed to draw conclusions and make recommendations.

Results

Research has shown that the Heart Center produces multiple types of waste: infectious medical waste, sharps, residual waste, paper, and cartons. The proportion of residual waste is high. The majority of the residual waste consists of plastics, which have the potential to be recycled. Literature research shows a broad overview of sustainable initiatives in the healthcare sector. Within Isala, implementing sustainable initiatives requires a lot of time and effort because of laws, regulations, and long-term contracts with suppliers. To create urgency, health care workers have to be informed about sustainability and its implications. The interviews within Isala also reveal that collaboration and internal alignment within the hospital is important. From the interviews with hospitals, every Heart Center is using different methods to implement sustainability and reach a waste reduction, for instance separating plastics. Organisations can consult hospitals in the field of sustainability. To sum up, organisations are offering biodegradable disposables, recycling options, repairing options, decontamination and recycling techniques for infectious waste, and providing advice on a hospital's waste management or procurement policy.

KPIs selected from literature

To determine whether the effect of a waste management initiative is profitable, KPIs are selected that safeguard the environmental, economic, and social perspectives of sustainability. For example, the number of recycled materials compared with the total number

of materials. These KPIs could be visualised on a dashboard, which can improve the usability and the feasibility of sustainable initiatives as their results can, then, be displayed more clearly.

Conclusion and recommendations

It is not an option for Isala to stay behind in terms of the developments and the fulfilment of the signed Green Deal any longer. Waste streams at the HCKs of Isala's Heart Center can certainly be made more sustainable. There are different ways to achieve a waste reduction. However, capacity and collaboration between stakeholders is required to succeed in implementing sustainable initiatives. Even though, the potentials are high but the Heart Center has to consider the available options and create the capacity to invest in sustainability. Other parties are involved in the process of implementing sustainable initiatives, such as the procurement department or suppliers. Thus, internal alignment and more capacity are of great importance to successfully implement sustainable initiatives. Outsourcing sustainability management and waste reduction services to organisations allows hospitals to focus on their area of expertise: providing professional healthcare. The recommendations that follow from this study can be summarised in ten points of advice:

1. Create awareness among the employees of Isala and develop a Green team for the Heart Center
2. Create internal alignment on sustainable topics within Isala.
3. Get advice on sustainable waste management or sustainable procurement from organisations that are experienced in the waste industry and healthcare sector.
4. Rethink the number of disposables and consider biodegradable and environmentally-friendly alternatives for disposables that are lighter in weight.
5. Start using personalised and reusable coffee cups.
6. Start separating plastic and have an organisation collect waste from the hospital for recycling.
7. Increase the capacity of the procurement department to invest in sustainability and reconsider a more sustainable policy.
8. Rethink the amount of packaging material and discuss this with the supplier.
9. Use recycled versions of the yellow barrels for infectious waste and reconsider the infectious waste in the yellow barrels and think of options to decontaminate and recycle this type of waste subcontracted to an organisation.
10. Develop a dashboard for measuring the effects of sustainable measures.

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List of Acronyms

CE	Conformité Européenne
HCK	Heart catheterisation room
HDPE	High-density polyethylene
IISD	International Institution of Sustainable Development
ISO	International Organisation for Standardisation
KG	Kilogram
KPI	Key performance indicator
LCA	Life cycle assessment
LDPE	Low-density polyethylene
MDR	European regulations for medical devices
MST	Medisch Spectrum Twente
OR	Operating room
PETE	Polyethylene terephthalate
PMD	plastic, metal, and drink cartons
PP	Polypropylene
PS	Polystyrene
RIC	Resin identification code
RIVM	National Institute for Public Health and Environment
SRP	Socially responsible procurement
V	Polyvinyl chloride

1 Introduction

This research report, for the Bachelor's program Health Sciences at the University of Twente, focuses on improving the sustainability at the Heart Center of Isala hospital in Zwolle. In Section 1.1, the organisational context is explained. Section 1.2 describes the problem identification including the action problem, core problem, and problem cluster. Then, in Section 1.3 the research questions are formulated. Finally, Section 1.4 describes the stakeholders of this research.

1.1 Research Context

The organisation in which the research takes place is Isala hospital located in Zwolle. Isala is a top clinical hospital and part of the STZ (Collaborating Top Clinical Training Hospitals) [5]. The mission of Isala is committed to optimally restoring, maintaining, and enhancing the quality of life of the people entrusted to its care. This mission is based on different core values: openness & transparency, professionalism, and with heart & soul [6]. Isala has other locations in Steenwijk, Heerde, Meppel and Kampen. Isala's Heart Center is a department located in Zwolle that offers special types of treatment for patients with cardiovascular diseases [7]. The rooms in the Heart Center where surgical procedures are performed, are called heart catheterisation rooms (HCKs) [6]. At the Heart Center, there are six of these HCKs. Here, various treatments are performed: treatments for narrowed coronary arteries (coronary suffering), stenting treatments, treatments for arrhythmias, atrial fibrillation, and heart valve operations [7]. Although Isala is already taking several measures on the topic of sustainability in other departments, such as the OR (operating room) and Clinical Pharmacy, the Heart Center is regarding this topic still in the start-up phase.

1.2 Problem identification

The healthcare sector has a major impact on the environment. At least 7% of the CO₂ emissions have been caused by the healthcare sector [8]. At the moment, sustainability in the healthcare sector is still little or not taken up [9]. Many materials and medicines are thrown away, of which a large portion is unused, due to hygiene protocols. In addition, plastic waste is not recycled in many cases. Currently, there is little understanding of the costs and ecological impact of those high volumes of waste in the healthcare sector. Thus, the healthcare sector can make a major contribution to CO₂ reduction. These CO₂ reductions can help to reverse climate change and have a positive effect on public health [10]. For example, it results in an increase in smog and the emergence of new diseases. In conclusion, it is of great importance to get insight into the waste of hospitals and how to perform surgeries in a more sustainable way [8].

1.2.1 Action problem

The number of initiatives around sustainability in healthcare is increasing. The Netherlands aim to reduce CO₂ emissions and move towards a CO₂-neutral healthcare sector by 2050 [11]. This amounts to a reduction of 6 to 8% per year. There are several Green Deals from the RIVM (National Institute for Public Health and the Environment) that include targets to reduce CO₂ emissions [9]. Because healthcare is a major polluter in terms of climate effects, a Green Deal 'Sustainable care for a healthy future' has been established [11]. Sustainable care is about making people healthy with as few harmful substances as possible [10]. The Green Deal sustainable care has set several goals to become more sustainable: reducing CO₂ emissions, promoting circular care, reducing drug residues in

water, and creating a healthy living environment inside and outside of healthcare institutions. However, concrete measures are needed to further reduce CO₂ emissions [12]. Currently, little research has been conducted on the topic of sustainability in hospitals [13].

The research done for this thesis focuses on the sustainability of the HCKs at the Heart Center of Isala Zwolle. Within Isala, several Green Teams have been established, consisting of employees with different areas of expertise who want to contribute to sustainability at Isala. Among other things, these Green teams are looking at making the ORs and Clinical Pharmacy more sustainable. These two departments are major consumers of materials and waste [9]. For example, the OR produces as much as 20-30% of the total hospital waste [14]. In the Clinical Pharmacy department, there is much to be gained in terms of medication waste. It is estimated that medicine wastage in the Netherlands amounts to 100 million euros per year [8]. Besides the OR and Clinical Pharmacy, waste originates from various departments inside the hospital. For instance, the Heart Center is a big department where a lot of surgeries are taken place in the HCKs and hence a contributor of waste [7].

The Heart Center is a new player in the field of sustainability. At the Heart Center, there may be wastage in many areas, however, there is a lack of knowledge on the costs and impact of these. Many expensive materials are purchased for the Heart Centre. There is also a big variety in materials, which results in large inventories. For example, to perform a cardiac catheterisation, several sizes of materials are needed, due to the wide variety of sizes of patients. This results in many last-minute operations in inventory management at the Heart Center. Besides that, the expiration date of the material must be considered. Currently, there is little action to become more sustainable at the HCKs. Thus, there is a lack of insight and knowledge how to deal with sustainability and how to implement sustainable initiatives. Regarding existing measures to achieve sustainable hospitals, there is little knowledge on what measures are taken in other departments and hospitals and how effective these are.

1.2.2 Problem cluster and core problems

A problem cluster is a tool to understand the relationships between the problems [15]. Figure 1 shows the problem cluster that outlines the current situation at the HCKs. The light blue boxes describe the core problems. The first core problem is the lack of knowledge on how to make waste streams more sustainable at the Heart Center. The second core problem is the lack of knowledge on how to make inventory management more sustainable. This thesis will focus on the first core problem, because of the high potential to significantly reduce in waste. This core problem is shown in bold in the problem cluster. The focus of the research are the waste streams of the HCKs at the Heart Center at Isala Hospital in Zwolle. Thus, from the perspective of the HCKs, there is a great need to become more sustainable, for example by separating or reducing waste. Therefore, it is important to map the waste streams and identify their bottlenecks.

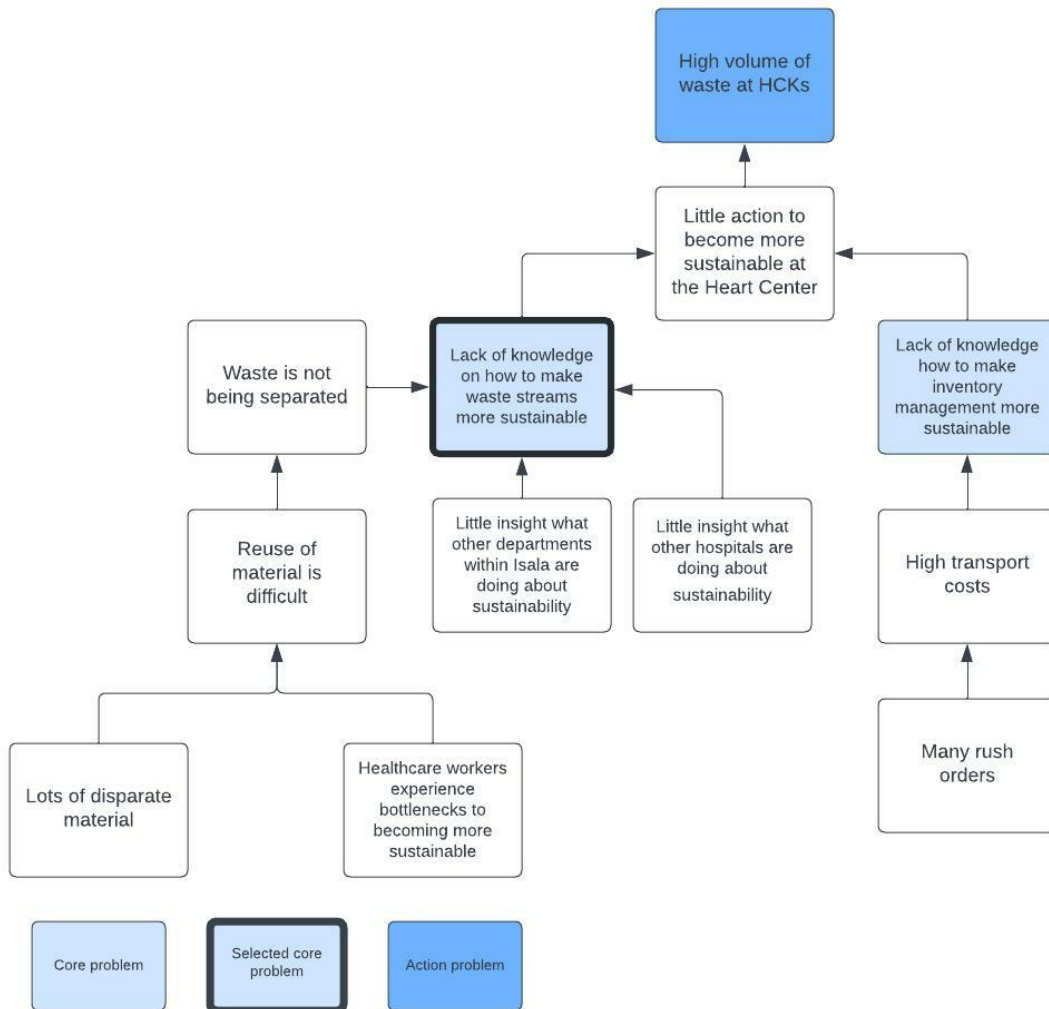


Figure 1: Problem Cluster

1.3 Research questions

Reducing medical waste contributes to sustainability and thus to a reduction of CO₂ emissions in healthcare [16]. By reducing medical waste, the dependence on natural resources is also reduced. Medical products can be regarded as scarce when evaluating the abundance of the raw materials. Waste reduction and recycling also contribute to the finances of a healthcare facility. Also, medical waste has a harmful effect on public health and the eco system [10]. In conclusion, the healthcare sector can make a great contribution to the reduction of CO₂. Based on the problem cluster in Figure 1, the goal of this research is to solve the core problem which is the lack of knowledge on how to make waste streams more sustainable at the HCKs. The identified problem leads to the following research question:

”To what extent can the waste streams at the HCKs of Isala’s Heart Center in Zwolle be made more sustainable?”

To solve the core problem and answer the main research question, we formulate several sub-questions to accompany the main research question. These questions are numbered and further described in Chapter 3. The research questions also serve as chapters in this thesis.

-
1. What is the current situation of waste flows at the HCKs?
 2. What initiatives about the sustainability of waste streams can be found in the literature?
 3. What initiatives are already in place within Isala to make the waste streams more sustainable?
 4. What initiatives on sustainable waste streams already exist in other hospitals in the Netherlands?
 5. What initiatives to increase the sustainability of waste streams are offered by companies?
 6. What key performance indicators (KPIs) are important in measuring the usefulness of an initiative for the Heart Center?
 7. What are the most suited waste management initiatives for the Heart Center?
 8. To what extent does the behaviour of healthcare workers play a role in making waste management more sustainable?

1.4 Stakeholders

Regarding the topic of sustainable waste management, multiple persons and functions are involved. To determine important stakeholders, a stakeholders analysis has been done. The influence of stakeholders and the impact on stakeholders are mapped in a stakeholder analysis. Different parties are involved: university supervisor, organisations supervisor, manager Heart Center, Board of Directors, purchaser Heart Center, Cardiovascular nurses, Cardiovascular technicians, cardiologists, patients, other hospitals in The Netherlands, and waste management companies. This analysis can be found in Appendix A.

2 Theoretical Framework

Various literature has been reviewed to gain insight into sustainability in healthcare. This chapter is based on several studies from the available literature that offer relevant information to answer the problem statement. Various subjects are described to explain important methods and concepts while performing research about sustainability in healthcare. A method to create sustainable care is described in Section 2.1. After that, techniques on how to measure sustainability in healthcare are discussed in section 2.2. Subsequently, Section 2.3 explains the circular economy in the field of healthcare. Section 2.4 discusses the concept of medical waste. Lastly, Section 2.5 presents a conclusion of the literature review.

2.1 Steps to sustainable care

Improving sustainability in hospitals requires a systematic approach. Multiple steps have to be taken to perform research on sustainability. The first step is to choose a focus [9]. Making hospitals sustainable in practice requires cooperation between many different stakeholders. The involved stakeholders are shown in Appendix A. When choosing a focus, it is for example possible to identify the major waste contributors are within a process. These are so-called hotspots. After choosing a focus, different types of measures can be considered. Hospitals have multiple options in the field of contributing to sustainability and thus reducing CO₂ emissions. In addition, a hospital can purchase products or services that are more environment-friendly. Examples are sustainable materials such as reusables or instruments from recycled material. The healthcare professionals also play a major role in the field of sustainability [9]. Creating awareness among healthcare professionals is of great importance. Furthermore, the effects of certain initiatives have to be estimated. Namely, the main question is how sustainable a certain measure actual is. These measures need to be evaluated, although they require implementation to analyses their effects.

Multiple ways of reducing the carbon footprint, and thus contributing to sustainability in hospitals have been discussed in existing literature [12]. As the ORs are known to be major emitters of CO₂ emissions in hospitals, several studies have been carried out focusing on those ORs [9]. These studies showed that there are some important elements that contribute most to sustainability in the OR: air treatment, collect and reuse emissions of inhalation anaesthetics, responsible purchasing, and a reduction of waste. [12]. As HCKs can be defined as operating theatres at the Heart Center, this information is also useful for HCKs. Waste production can be reduced through circular procurement, choosing reusable products over disposables, and recycling where possible [17].

2.2 Measures of sustainability in healthcare

Sustainability in healthcare is a multidisciplinary topic in the field of operations management and medical science [18]. The concept of sustainability has been applied in many different contexts. The International Institution of Sustainable Development (IISD) defines the concept of corporate sustainability as ‘adopting business strategies and activities that meet the needs of the enterprise and its stakeholders today while protecting, sustaining and enhancing the human and natural resources that will be needed in the future’ [19]. To achieve sustainability in healthcare, there are three dimensions developed in the Conceptual Model for Sustainability in Healthcare developed by Mehra & Sharma [18]: environmental, social and economic. The environmental dimensions expands the environmental perspective from circular economics and the three Rs: reduce, reuse and recycle . There are different processes within the environmental dimension, such as waste reduction

and management. Furthermore, there is a social dimension which describes for instance the patient and workforce satisfaction. Health outcomes and healthcare consumerism should be treated as KPIs. The satisfaction of the healthcare employees has a significant impact on patient satisfaction as well. The final dimension is about economics. The economic dimensions focuses on research, innovations, profits and saving in operational costs.

2.3 Circular economy in healthcare

As already mentioned in Chapter 1, as stated by the RIVM (National Institute for Public Health and the Environment), the Netherlands has a goal to reduce CO₂ emissions [11]. Agreements to achieve this goal in the healthcare sector are described in the Green Deal Duurzame Zorg (Green Deal Sustainable Care) [11]. Energy can be saved in processes such as in buildings (e.g. hospitals), mobility, procurement, and the application of EHealth [13]. Part of this Green Deal is to stimulate circular working in the healthcare sector.

There is a shortage of available raw materials [20]. Therefore, it is important to reduce wastage in general. Circular working prevents wastage throughout the chain, starting from production to waste disposal. From the circular economy's point of view, the best way is to see if waste can be avoided or reduced [1]. Then, it is examined whether products can be used longer before they are discarded. The least preferred option before incineration/landfill is that, products are considered for recycling after they are discarded. The ultimate goal is to make the circular economy a fixed part of the purchasing process. Life cycle assessment (LCA) is a method for determining the emissions of harmful substances by the healthcare sector [13]. Environmental impacts are translated into consequences for human health [13]. LCA is a form of chain analysis. The entire chain is examined, resulting in a list of hotspots of environmental effects. Unfortunately, carrying out an LCA often costs a lot of time and money [13].

When a material is reused, costs can be saved. A circular economy makes it possible for products to stay at their highest level of value for as long as possible [1]. The Value Hill of Achterberg in a circular economy is a circular business strategy tool. This tool is analyses the paths products take during their life cycle. The Value Hill is divided in three phases: pre-use phase, use phase, and the post-use phase. In the final phase, a product loses its value and moves downhill in the model. It is possible to redirect a product, or part of it, to its previous phase. In that case, the value is recovered. Business models in the post-use phase generate value from used products or waste. Different business strategies models correspond to resource recovery, whereas the Value Hill is about retaining value in used products.

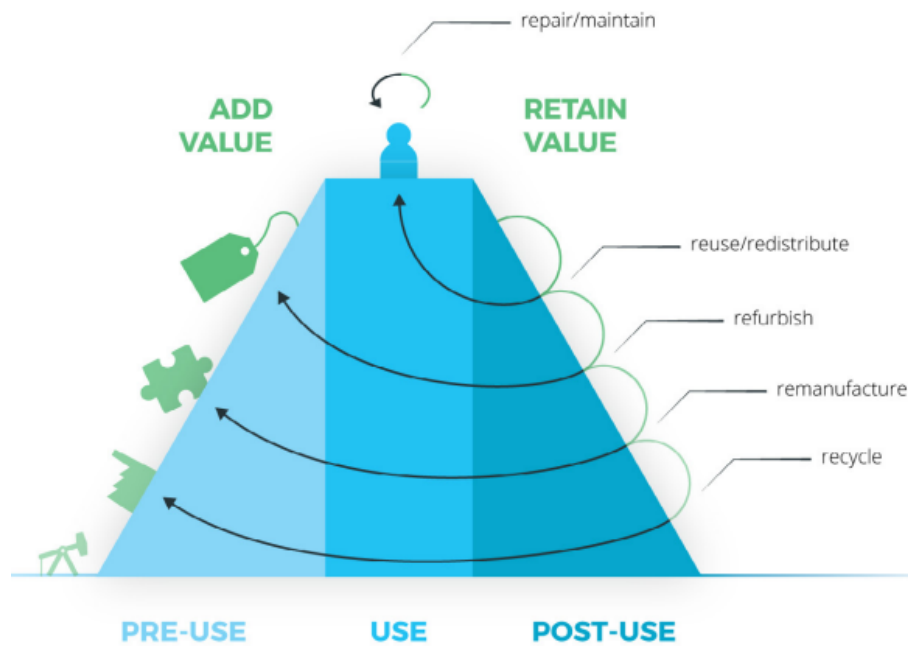


Figure 2: Value Hill[1]

Another tool for products, focusing only on the post-use phase, is the Ladder of Lansink [2] as shown in Figure 3. This tool offers waste management hierarchy and consist out of four ways to handle waste. These four ways are prioritised. First, the highest priority is preventing or reducing waste (A). Furthermore, B and C are about the highest possible reuse. The next step is the incineration of waste with the aim of generating as much energy as possible (D and E). Lastly, the least desirable form is landfill or discharge (F) [2]. The key message of Lansink's ladder is that separation at the source is preferable to separating it afterward. And reusing is better than recycling [2]. For example, a study by Van Straten [16] shows that reusing materials saves a quarter of the purchase costs of Dutch hospitals. Lansink's ladder is a common tool in waste management and thus suitable for the waste management at hospitals [21].



Figure 3: Lansink's Ladder[2]

2.4 Hospital waste

The production of waste in hospitals is constantly increasing. This is partly explained by the increased demand for care [22]. In addition, in recent years there has been an increase in the use of disposables instead of reusable materials [12]. Reasons for this are to avoid infections, have more convenience, and cost reduction. On average, a surgery results in 12 kg (kilogram) of waste [23]. Hospital waste is defined as all waste generated in hospitals [24]. There are two types of healthcare waste. First, the non-hazardous waste which is similar to households waste. And second, hazardous waste or infectious waste which can cause danger to the human health and environment [24]. Recycling materials in ORs is a possible solution, but there is a lack of knowledge about what can and cannot be recycled which is of great importance since some materials are infectious [22], [17]. However, most of the packaging and disposables are made of plastic. Recycled materials are rarely used in ORs as raw materials for similar products. That is why it is more valuable to first reduce and reuse waste, whilst keeping recycling as a possible ensuing step. Recycling is an important way of ensuring that valuable raw materials are not wasted in the circular economy. OR staff give several reasons for not recycling: lack of time, inconvenience, lack of knowledge and lack of incentive from management [17]. This is also applicable to the ORs of the Heart Center, the HCKs.

2.5 Conclusion

From this literature research, it can be concluded that sustainability must be an essential part of the business plan of healthcare organisations. Hereby, it is important to take the three dimensions of sustainability, environmental, social, and economic, into account [18]. These dimensions are applied in this research and are included into the research questions. The focus lies on the post-use phase of the Value Hill [1]. However, the three Rs of Lansink's Ladder are chosen to use in this research instead of the Value Hill of Achterberg. The Value Hill gives insights in business models for circular economy and extracting maximum value [1]. Because preventing is the most prioritised measure to manage waste, Lansink's ladder is used. In hospitals, there is most to be gained from Lansink's Ladder and the three Rs (reduce, reuse and recycle) [2].

Besides the waste management tools, there are different ways such as sustainable purchasing, waste reduction, waste management, and employee satisfaction that lead to savings in operational care. Thereby, disposables are more expensive in the long run. Based on the reviewed literature, there are multiple ways to include sustainability in healthcare. The focus lies on making the waste streams at the Heart Center more sustainable. Thus, the next Chapter 3 describes the used method in this research.

3 Research Design

This chapter describes the method of how the research questions are answered in this research. Figure 14 in Appendix B describes an broad overview of the research design and contains the research question, type of research, type of population, subjects, research strategy, method of data gathering, and processing and activities. Every chapter of the thesis is connected to certain research questions. The overall research design is qualitative. Questions are answered in a descriptive as well as explanatory way. Several sustainable initiatives are investigated from various perspectives: environmental, economic, and social [18]. This chapter describes the research scope in Section 3.1. Subsequently, the problem-solving approach is written in Section 3.2. After explaining the research scope, the deliverables of the research are described in Section 3.3. The next Section, 3.4 is about the validity and reliability of the research. Next, the limitations are described in Section 3.5. Finally, the interview method is explained in Section 3.6. This chapter describes the method on how the research question *"To what extent can the waste streams at the HCKs of Isala's Heart Center in Zwolle be made more sustainable?"* is answered.

3.1 Research scope

As already mentioned, the focus of this research is the waste streams at the HCKs of the Heart Center of Isala in Zwolle. This scope is chosen because of the lack of knowledge and insights into sustainability in this department in contradiction to other departments within Isala. Thereby, at the Heart Centre, there is a desire to change in the field of sustainability among care workers and cardiologists. This research design provides a plan to answer the research questions in this report. Each step is further explained in this chapter.

3.2 Problem-solving approach

To provide a clear structure, a methodology is used to solve the problem. The chosen core problem is the lack of knowledge on how to make waste streams more sustainable. This problem can be mentioned as a knowledge problem. The action problem, as shown in Figure 1, describes the high volumes of waste at the HCKs. The method used in this research is the research cycle developed by Heerkens van Winden [15]. This research cycle consists of eight phases. These steps help to provide an answer to multiple research questions. Each phase is further explained combined with belonging research questions and the approach. The first four steps of the research cycle are part of the research proposal.

1. **Formulating the research goal:** First, it is important to create a clear goal for this research. The research goal is to investigate different initiatives for sustainable waste management which are contributing to the large amounts of waste at the HCKs, and write recommendations on waste management initiatives for the Heart Center of Isala.
2. **Formulating the problem statement:** To get an insight into what the relevant problems are, literature research has been conducted in the orientation phase of this research. Besides that, practical experience has been created in the preparatory phase of this research. This practical experience consists of interviewing and gathering information from involved persons and Green Teams within Isala. In addition, an unstructured observation at the HCKs has taken place to get a first impression. After gathering this information, a problem statement is developed. This phase partly answered the first research question: *What is the current situation of waste flows at the HCKs?* This question is answered partly in Chapter 4.

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3. **Formulating the research questions:** After developing the problem statement and creating a problem cluster, research questions have to be formulated. The orientation phase leads to a broad overview of the main problem. Therefore, different research questions are formulated in Section 1.3.
 4. **Formulating the research design:** After formulating the research questions, the research design is discussed. First, a broad overview of the approach of each question is made as shown in Appendix B. Each research question is answered through different methods.
 5. **Performing the operationalisation:** A strong theoretical framework (Chapter 2) is required to perform the fifth step of the research cycle. There are a lot of concepts and methods which have already been used in sustainability studies in healthcare. These concepts have to be made clear. Besides the theoretical framework, additional literature research has to be done for defining KPIs and developing questions for interviews.
 6. **Performing the measurements (gathering data):** This step consists of multiple steps which are described separately.

- (a) **Current situation:** The problem is analysed in more detail in this phase. This research question aims to gain insight into the current situation: *What is the current situation of waste flows at the HCKs?* The method of gathering data is direct unstructured process observation. The waste flow process has been identified by observing and talking with persons involved at the HCKs. The observation is direct and unstructured and consist of one observation of a day at several surgeries at HCKs. First, the behaviour of the care workers at the HCKs has been observed. Because of the unstructured observation method, there is no use for a pre-established observation schedule. At the HCKs, as much as possible information has been gathered to get insights into the problems. The most important aspects are analysed to create more detailed observation data. Results from observations and conversations with persons involved are used to describe the current situation.

After analysing the current situation, possible waste management initiatives are collected. These initiatives are from literature, other departments at Isala, other hospitals in the Netherlands, and companies.

- (b) **Initiatives from literature:** The second research question is answered by means of a literature study about already existing initiatives regarding the sustainability of waste streams: *What initiatives about the sustainability of waste streams can be found in the literature?* It is a cross-sectional literature study. Different literature will be reviewed. Next, a list of initiatives for sustainable waste management from the literature is composed. Different activities are conducted to answer the second research question. After the literature study, potential initiatives for the Heart Center are selected and described.
- (c) **Initiatives from other departments at Isala:** After a literature study, it is of great importance to get insight into sustainable measures from Isala itself. For this reason, research question 3 is about the existing initiatives within Isala: *What initiatives are already in place within Isala to make the waste streams more sustainable?* The problem cluster shown in Figure 1 clarifies, from the

perspective of the Heart Centre, that there is a lack of knowledge about what other departments are already doing about sustainability within Isala. Thus, it is of great relevance to get insights into these initiatives and determine if these initiatives are usable for the Heart Center. In the orientation phase of the research, several Isala Green Team meetings have been attended. Due to these Green Teams, a selection of departments has been made to gather more information about the initiatives at Isala. The departments that do the most in terms of sustainability are the OR, Clinical Pharmacy, and Radiology. To answer research question 3, three interviews will be conducted with the three departments that do the most in the field of sustainability. According to the interview data, a list of potential waste management initiatives will be described to give an overview of the initiatives within Isala which are possibly suitable for the Heart Center.

(d) **Initiatives from other hospitals:** Research question 4 is about the initiatives on sustainable waste management outside Isala: *What initiatives on sustainable waste streams already exist in other hospitals in the Netherlands?* A literature study among hospitals in the Netherlands indicates the most sustainable Heart Centers or hospitals. According to this information, a selection of three hospitals has been made to conduct three interviews about the initiatives on sustainable waste management. It was decided to exclude academic hospitals in order to obtain data of hospitals that are of a similar type, as academic hospitals tend to have different organisational structures compared to top clinical ones. The selected hospitals are Ter Gooi Hospital, MST (Medisch Spectrum Twente), and Hospital 3 who wants to participate anonymously. Three semi-structured interviews will be conducted for further analysis. Potential initiatives for Isala, have been derived from data obtained through these interviews.

(e) **Initiatives from companies:** There are also a lot of companies that offer different tools for sustainable waste management. For example, companies who are helping hospitals to separate their waste or companies who that provide hospitals with other types of materials instead of plastic. That is why three companies are interviewed to answer research question 5: *What initiatives to increase the sustainability of waste streams are offered by companies?* Different literature has been reviewed to make a selection of the potential companies. Besides the literature study, there have been several conversations and calls with involved persons to select companies: the head of purchasing, senior purchaser for HCKs, Green Teams, and an IC physician from Radboud UMC who performed a lot in the field of sustainability. According to these conversations and the literature a selection of companies has been made: Innomax BV, Greencycl and, Green it Out. Besides those three companies, two others have been contacted but did not response. The interviewed companies are further described in the accompanying chapter. After the interviews are conducted, a list of potential initiatives for the Heart Centre is described.

7. **Processing the data:** After collecting different initiatives for sustainable waste management from literature, Isala, other hospitals, and companies, the effect of the initiatives for the Heart Center should be measured. Research question 6 is about the KPIs which can be used by measuring the usefulness of a waste management initiative for the Heart Center of Isala: *What KPIs are important in measuring the usefulness of an initiative for the Heart Center?* This research question provides

an answer to the most useful KPIs by measuring the value of a waste management initiative for the Heart Center. These KPIs are found in a cross-sectional literature study. An overview of KPIs is written down and can be used to measure the effect when sustainable initiatives are implemented.

8. **Drawing conclusions:** When the most suited KPIs are selected, the list of different waste management initiatives are evaluated in research question 7: *What are the most suited waste management initiatives for the Heart Center?* This explanatory question provides a final selection of the most suited waste management initiatives for the Heart Center. This selection is the recommendation chapter of this research. Thereby, this selection results in an answer to other questions.

When implementing a more sustainable waste management initiative, it is of great relevance to take into account the behaviour of care workers at the Heart Center. Thus, research question 8 is about the behaviour of the healthcare workers in making waste management more sustainable: *To what extent does the behaviour of healthcare workers play a role in making waste management more sustainable?* The social perspective researches the role of healthcare workers when there is a change happening in sustainable waste management. To get insights into the behaviour of healthcare workers, a cross-sectional literature study will be conducted about behaviour change management and is described as a common thread through the report.

3.3 Deliverables

The main intended deliverable is the research about sustainable waste management for the Heart Center of Isala. Hereby, insights into how sustainable waste management is possible are described. These sustainable waste management initiatives are from literature, other departments at Isala, other hospitals in The Netherlands, and companies. Subsequently, this research offers a list of KPIs which can be used by determining the effect of waste management initiatives. However, measuring the usefulness is possible after implementing an initiative. It is up to the Isala what the hospital is going to implement. After implementation, available data can be visualised to measure the effect of sustainable waste management initiatives. Due to the lack of data, only a recommendation can be done in this research to visualise effects with selected KPIs.

3.4 Validity and reliability

Validity and reliability are important to be analysed to measure the quality of research. Validity is about whether the research has measured what it intended to measure [15]. This research aims to investigate different sustainable waste management initiatives. There are three types of validity. Internal validity is about whether the research design has been properly formulated. For this research, it is important to use consistent interview schemes and communicate clearly. The data from the interviews and the lists of waste management initiatives have to be clearly and consistently formulated. External validity concerns the extent of the research can be applied to other groups [15]. When this research is finished, it should be broadly applicable to other hospitals or other Heart Centers. The last type of validity is construct validity. Construct validity is concerned with whether concepts have been properly operationalised [15]. The KPIs for determining the usability of waste management initiatives are formulated consistently with the help of literature research. Different concepts belonging to sustainable waste management are researched in literature and in practice.

Reliability is the extent to which the research is consistent [15]. In this research, different departments, hospitals, and companies are used to gather data. When changing the interviewed hospitals or interviewing different companies, this will possibly lead to different results, because every hospital applies different waste management. To ensure the reliability of an interview, it must be as structured as possible. Interview data is gathered and analysed. Thereby, a clear interview scheme and clear KPIs that can measure the usability will contribute to the research's reliability. However, sustainability in healthcare is a hot topic and initiatives are increasing. Therefore, when this research is conducted later, more sustainable initiatives are possibly developed. From the government's side, CO₂ has to be reduced according to the Green Deal. This means hospitals who signed the Green deal are obliged to change. Thus, when the research is repeated five years later, there must be a change.

3.5 Limitations

Every research knows its limitations. In this research, the main limitation is the constraint of time. This research consists of ten weeks, excluding the preparatory phase when the research proposal is written. Therefore, it is important to delineate the research such that it is achievable within the ten weeks. To deal with this time constraint, the focus is defined on only three other hospitals and only three companies that offer sustainable waste management initiatives. Besides that, recommendations in this research could be a follow-up study.

3.6 Interviews

To get an overview of the different initiatives regarding waste management sustainability initiatives, nine interviews are conducted at other departments at Isala, other (sustainable) hospitals, and companies who are offering waste management initiatives. The interviewees are recruited/contacted by mail or telephone. All interviews are semi-structured. For the interviews from other departments at Isala and hospitals, an interview schema is developed with relevant topics and belonging questions as shown in Appendix C. For the companies, the topics of the interview depends on what the companies offers to hospitals. Therefore, a different and shorter version of an interview scheme is used, which can be found in Appendix D. The interviews are transcribed. After transcription of the interviews, each is analysed systematically. The transcription is analysed by coding the interviews. For each interview, an informed consent is signed before the interview is taken place.

4 Current situation of waste flows at the HCKs of Isala

This Chapter describes the current situation of waste management at the HCKs and provide an answer to Research question 1: *What is the current situation of waste flows at the HCKs?* At the Heart Center at Isala in Zwolle, there are currently six HCKs. In this chapter, it is described how waste is currently managed at the HCKs. During the surgery, there is a lot of infectious waste, also known as specific hospital waste or hazardous waste, which is described in Section 4.1. Subsequently, Section 4.2 describes the way waste is begin separated on the HCKs, which is zoomed in on the residual waste.

4.1 Infectious waste

Different regulations apply regarding waste at the hospitals in The Netherlands. Part of the medical waste has to be deposited in yellow boxes. This type of medical waste is hazardous and is called infectious waste. Infectious waste is released during medical treatments and includes body fluids, tissues, and anything that is touched during the surgery, such as gowns, gloves, and sponges [25]. Other names for infectious waste are hazardous waste or specific hospital waste. In this research, the term infectious waste is used. Infectious waste has stringent requirements for hygiene, storage, transportation, and processing the waste. healthcare workers are responsible for handling infectious waste safely [26]. In 2019, the total number of infectious waste of Isala Zwolle was 396.580 kg. At the HCKs, this infectious waste is discarded in a yellow barrel. There is a minimum of 12 yellow barrels and a maximum of 18 yellow barrels at the Heart Center per day [7]. Each yellow barrel is collected and incinerated by the waste processor. Processing those yellow barrels requires an energy-intensive process.

4.2 Separating waste

Waste separation protocols are described in a platform named Zenya for Isala. This platform provides Isala with the regulations about waste in hospitals. Every type of waste has to be registered according to the organisational rules from Isala and their contract with the waste processor. At the Heart Center, paper and carton is already been separated. At the HCKs, there is also a small barrel for sharps such as needles or syringes. The other waste is deposited as residual waste. in 2019, the total residual waste of Isala Zwolle was 967.286 kg. According to the observations, each surgery leads to an average of one garbage bag of residual waste from 60 litres. At the HCKs, healthcare workers are already using reusable surgical gowns and reusable blankets to avoid waste. Different surgery instruments are not disposable but made from stainless steel and are cleaned and sterilised at the hospital. Moreover, the Heart Center is collecting pace makers or heart devices due to the precious material. Figure 4 shows a broad map of the average HCK at the Heart Center. This figure shows the different types of waste, thus the current situation.

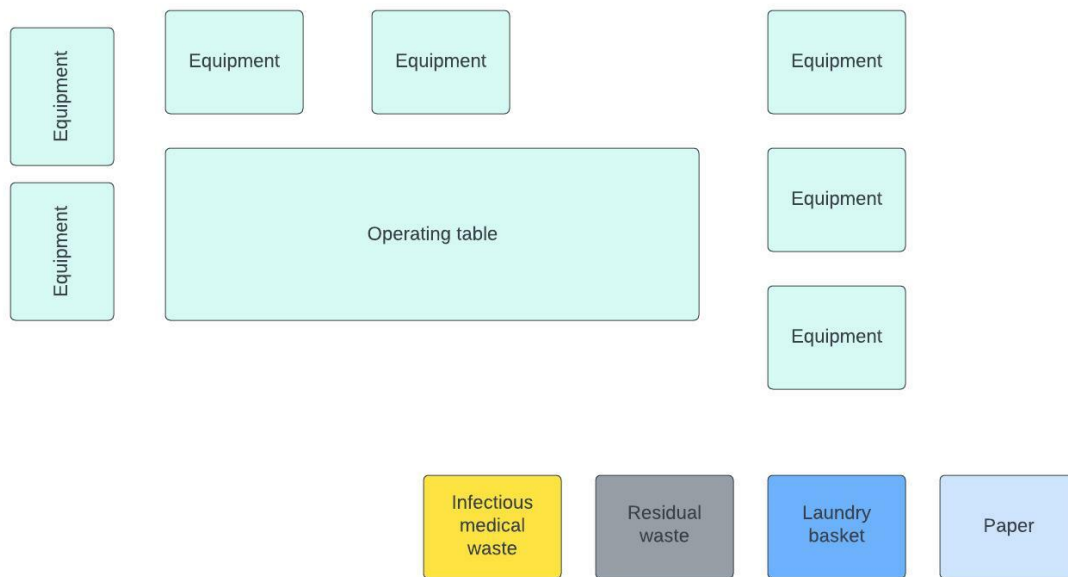


Figure 4: Broad outline HCK

Literature shows that, on an average, hospital waste consist out of 73% of residual waste [3]. According to a research among hospitals in The Netherlands, these 73% can be divided into sub categories as shown in Figure 5. As already mentioned, at the HCKs there are high amounts of residual waste. The biggest part of residual waste in hospitals are plastic laminated material. Together with the plastic packaging material, the total amount of plastic in the residual waste is 43%.

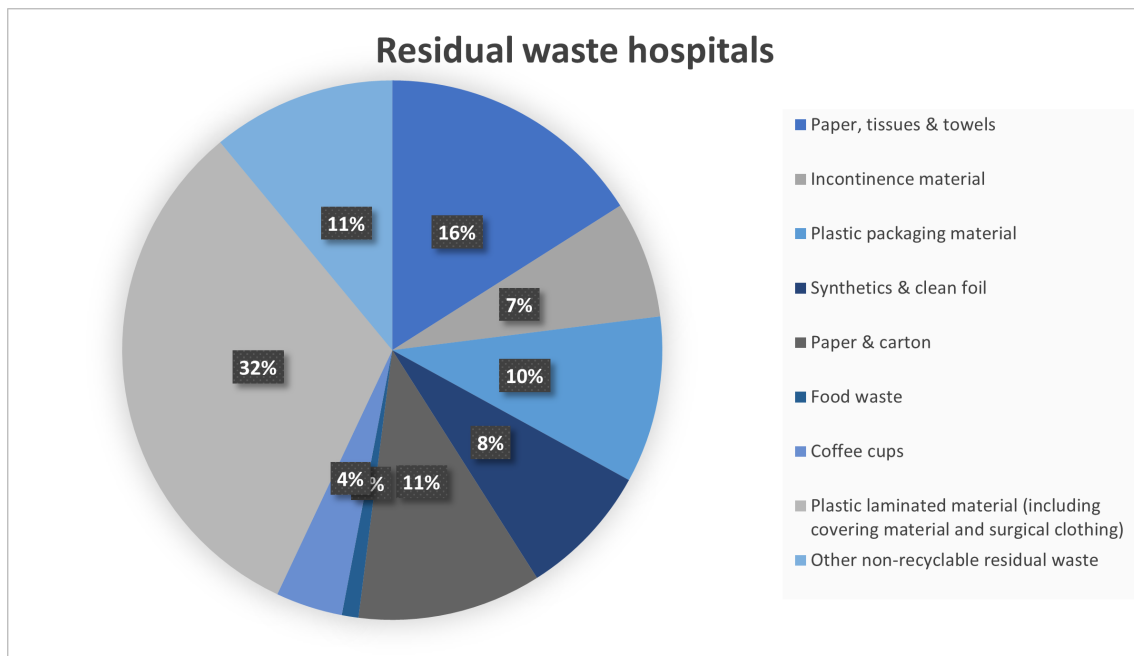


Figure 5: Residual waste hospital [3]

Plastics products have been used since the 1950s [27]. Plastics are widely recognised to be a major environmental burden. Between 1950 and 2015, only 9% of the plastics have been recycled [27]. The rest of these plastics is incinerated or discarded. Plastics have taken a stronghold in the healthcare industry because of their exceptional barrier properties, low cost, flexibility, and durability [27]. For plastics that have not been in contact with the patient, separation is possible [28]. Several clean types of plastics can be collected together in the mixed plastic waste stream despite of the fact that there are different types of plastics. The different types of plastics that are common in healthcare are shown in Figure 6. The Resin Identification Code (RIC) is created for workers in the recycling industry to be able to recycle and sort plastics efficiently [29]. Each number shown in Figure 6, refers to a typical type of plastic. The Heart Center also knows the different types of plastics at their department. PETE and HDPE are the most commonly used and recycled types of plastic within society [4]. An average OR generates several types of plastics: 28 to 39% polyethylene (RIC: 1, 2 & 4), 23 to 41% polyvinyl-chloride (RIC: 3), 9 to 21% polypropylene (RIC: 5) and 10 to 13% co-polymers (RIC: 7) [27].



Figure 6: Different types of plastic according to Resin Identification Code (RIC) [4]

5 Waste management initiatives

This chapter describes the main results of this research. To answer the main research question, several waste management initiatives are listed in this chapter. These initiatives are from literature, departments at Isala, other hospitals and companies. Section 5.1 describes the waste management measures found in the literature for hospitals and the behaviour of healthcare workers. The other sections are based on the information from the conducted interviews. Section 5.2 contains the waste management measures from Isala. Section 5.3 deals with the waste management measures from other hospitals. Finally, Section 5.4 describes the waste management measures from selected companies in the healthcare area. The results are analysed with the help of Lansink's Ladder. According to Lansink's Ladder, reduction or even prevention of waste is the most preferred option regarding to sustainability. After that, reuse and recycle are following [2]. These sustainable initiatives are not only applicable to the Heart Center, but in some cases other parties are involved. Some of the sustainable measures are applicable hospital-wide or applicable to the procurement department of Isala.

5.1 Waste management literature

This Section provides an answer to Research question 2: *What initiatives about the sustainability of waste streams can be found in the literature?* Improving the sustainability of waste streams requires fundamental principles [1]. There are different strategies to minimise waste according to Lansink's Ladder [2]. Currently, there is no convention that covers the management of medical waste [17]. The classification of medical waste varies from one country to another. In the Netherlands, infectious medical waste has to be collected in specific barrels [30]. On the HCKs, those barrels are yellow. There are strict rules in terms of the treatment of infectious waste. Thus, managing medical waste is complex, because the economic, social and environmental aspects have to be taken into account [24]. Thereby, laws and regulations playing a big role in the field of reducing, reusing en recycling. Different literature for sustainable waste management is consulted and described in this section.

5.1.1 Results

Research shows that more than 70% of general surgery waste, which has the potential to be recycled, is incorrectly disposed as infectious waste [31]. Thus, there is a large potential for reducing waste when implementing sustainable measures. From the literature, there are a lot of measures which can be implemented to improve the sustainability of waste. At the HCKs, there are a lot of disposable products, for instance catheters or plastic trays. These products are small and made for single-use, so sterilising is not an option [21]. For disposables, it is important to look at the reducing or recycling potential [32]. For example, materials can be made from biodegradable. When using biodegradable materials, the use of virgin materials is decreasing. Another opportunity is the sorting of disposables via plastic waste [28]. The design of specific material at the Heart Center is very simple, which makes it possible to be cleaned and sterilised. As a first possible step, the Heart Center could rethink about reusable instead of disposable. However, the reuse of products through sterilisation causes a new type of waste [21]. After sterilisation materials, material sets are wrapped up with green wrap and blue wrap. Blue wrap is not biodegradable but can be melted and recycled due to its polypropylene composition (RIC: 5) [33]. On the contrary, the material after sterilising is not fully reusable. Therefore, it would be much better if sterilising was possible in reusable packaging. The material at the HCKs is double packaged in most cases. There is a large amount of laminate bags, plastic

trays and sterilisation wraps. According to literature [21], it is relatively easy to separate the paper layer and polypropylene layer (RIC:5). As described in the current situation, there are a lot of plastics deposited in the residual waste. To separate plastics, an extra waste bin for mixed plastic could be created at the HCKs [28]. Optimal sorting could be realised to sort out a higher diversity of materials.

As already mentioned in Chapter 4, there is a lot of plastic waste at the Heart Center. When implementing a circular economy for plastics, the focus lies on reduce, reuse and recycle, as well as rethink and research [27]. According to Lansink, the best waste is the waste that is not produced [2]. For example, unopened and unused syringes are discarded after the end of a surgery because of the concert of infection. This results in a pervasive source of wastage in ORs. The amount of syringes can be reduced. Syringes can be unopened but available for preparation when needed [27]. Reusable alternatives are more cost-effective than single-use products in the long run despite costs of labour and sterilisation [27].

5.1.2 Sustainable procurement

Sustainable procurement plays a major role in reducing materials and minimise waste [34]. As a first step, sustainable procurement can be realised to start negotiating with the suppliers of material. The suppliers also have to be aware of the consequences of the large amounts of CO₂ emissions from the healthcare sector. Therefore, collaboration is of great importance between hospital and supplier. An option for sustainable procurement is a white paper [35]. A white paper provides insights into what legislation and regulation the suppliers have to meet with in the field of innovation and circular economy [35]. Due to legislation, it is difficult to meet the environmental requirements as a supplier. Standard specifications are developed in order to meet the safety requirements of medical devices and materials. Additionally, hospital and supplier could examine whether it is possible to make agreements on the return and recycling for waste. This also applies to coffee cups [28].

5.1.3 Behaviour of healthcare workers

This section provides an answer to Research question 8: *To what extent does the behaviour of healthcare workers play a role in making waste management more sustainable?* Implementing waste management measures at the Heart Center requires different working processes from the healthcare workers, therefore it is of great importance to study also on an employees behaviour. Waste handling is often an automatic process for healthcare workers [26]. People are aware of separating waste or not. When handling waste is adjusted, behavioural change is required by healthcare workers. From the literature, there are different existing measures which an organisation can take to realise behaviour change.

Awareness on waste reduction has to be created for healthcare workers. First, the Heart Center could ask employees to participate in thinking about improving their waste management, for instance the waste separation. Initiatives from healthcare workers are likely to generate support among the other healthcare workers [26]. The management have to inform the healthcare workers about the value of separating waste. Literature shows that there is little resistance among healthcare when they see outcomes from a sustainable initiative [14]. Thus, creating awareness among the Heart Centers employees is about informing them. This can, for example, be realised by posting messages about sustainable procurement and waste on Intranet regularly. According to a study from Dunphy [34], there was an substantial imbalance between personal values of healthcare workers and the

lack of action taken place in the working environment to support environmental sustainability. On the long-term, it is of great importance to put sustainability in healthcare education and professional development [34]. Behaviour change theories directed at both the organisational and individual levels [31]. It is suggested that clear systems of labelling and categorisation when separating waste will cause an increase in recycling [36]. In short, studies have shown that active employee involvement and keeping them motivated, supports managers in achieving changes in sustainable waste management.

5.1.4 Conclusion

To improve the sustainability of waste with the help of Lansink's Ladder [2], several measures are potentially suitable for the HCKs at Isala, according to the literature. The literature gives a broad overview of sustaining in hospitals and ORs or HCKs. However, a more detailed overview is needed from the other hospitals and companies, where information is gathered by interviewing. The sustainable initiatives from literature are listed:

- Purchasing items from recycled material that can be disinfected and reused [17].
- Adopt policies and procedures for the management of waste, e.g. on the procurement department [17].
- Rethink of the recycle options for the blue wraps.
- Establish effective policies in cooperation with authorised manufacturer of plastics for recycling.
- Reconsidering reusing materials, e.g. catheters or plastic trays.
- Adjust the standard instruments to the surgery and cardiologist so that never-used instruments does not need to be cleaned and sterilised.
- Plastic packaging foil(RIC: 1) is a great clean type of waste and easy to collect separately. This can be realised by placing bins for plastic foil collection only in places where a lot of packaging material is released [26].
- Develop an agree with the supplier on returning packaging material or leftovers.

5.2 Waste management measures Isala

This Section answered Research question 3: *What initiatives are already in place within Isala to make the waste streams more sustainable?* Three interviews are conducted from different Green teams within Isala. A few years ago, various Green teams were founded by healthcare workers who want to take action on enhancing the sustainability of hospitals. A Green team exists out of different healthcare workers who are working on sustainable ideas. The Green teams at Isala are performing in different departments. Although there are a lot of small Green teams who are just getting started, there are also three big Green teams that are already operating for a few years. Within Isala, the biggest one is the Green team of the OR. The Clinical Pharmacy is another department that also has one of the biggest Green teams of Isala. The third Green team is from the Radiology department. Each of these departments is interviewed to gain insight in their sustainable initiatives, mainly in the field of waste management. The interview structure is shown in Appendix C. Figure 7 shows the information about the participant's function and the Green team they are performing in.

Participants interviews Isala		
Respondent number	Function	Green Team
1.	Hospital pharmacist	Clinical pharmacy
2.	Manager OR	OR
3.	Research physician	Radiology

Figure 7: Participants interviews Isala

5.2.1 Results

From the three interviews, it appears that the Green teams have already started with thinking about sustainability. However, every Green team is currently at the beginning of the process of considering sustainable initiatives and reducing waste. Ideas to manage waste or reduce materials takes a lot of time and effort because of laws and regulations, which causes a negative effect on the motivation of healthcare workers.

The Green team Clinical Pharmacy focuses on the awareness of their employees as a first step. According to the hospital pharmacist (respondent 1), the awareness of employees is of great essence. During the pharmacist meetings, a short information round takes place where everyone can talk about topics such as sustainability. Thereby, Clinical Pharmacy has written about sustainability in a newsletter and created an idea board, where every employee was able to join the Green team and deliver input. Employees often desire results from sustainable initiatives, for example, care workers want to know what it brings in terms of costs or CO₂ reduction. Besides creating awareness among employees, Clinical Pharmacy also reconsidered the amount and way of packing material, a lot of material for the hospital is packaged at the Clinical Pharmacy department. This reconsideration resulted in the abolition of double packages because it was not necessary for meeting the hygienic rules. However, the abolition of the double-packaged material created in some cases resistance from care workers because they doubted the safety. Thereby, the Clinical Pharmacy production assistants had to package some materials differently. Expect the abolition of the double packages, the Clinical Pharmacy also reduces the number of disposable cups by using a personalised reusable cup.

HCKs are a type of surgery room at the Heart Center. Therefore, the sustainable measures at the OR are interesting for the HCKs. According to the manager OR (respondent 2), they started with cleaning surgical scissors. Usually, the surgical scissors are thrown away immediately after surgery. The cost of the surgical scissors lies around 400 euros. Cleaning these surgical scissors was outsourced to a company that offers to clean surgical instruments and offer them cleaned and CE-marked (Conformité Européenne) back to the hospital. Although these initiatives reduce the number of surgical scissors and thus waste, from a legal perspective it was hard to implement this at the OR. In the field of hygiene en legalisation, hospitals do not want to take any risks. To minimise this risk, hospitals throw large amounts of material away which is incinerated afterwards. Collaboration with other hospitals is important to oversee the legalisation and hygienic rules. Nevertheless, the reuse of materials contributes to a hospital's sustainability and also reduces the costs on the long term. Besides the complicated business case of outsourcing cleaning surgery instruments, the OR also reduces the number of cellular mats. Normally, three of those cellular mats are used per surgery. This turned out to be not necessary, and it was possible to reduce this amount from three to one cellular mat. This results in a reduction in the number of cellular mats which leads to a reduction in costs and waste. At the OR at Isala in Meppel, waste is already been separated. The largest difficulty according to the OR in the theme of separating waste is separating plastic waste, because of the high variety in

types of plastics.

At the Radiology department, they also start with the reduction of the cellular mats. Thereby, they are currently looking at lowering the use of contrast liquids. Those contrast liquids are also used during a heart catheterisation. At the moment these contrast liquids are pre-filled syringes. When half of this contrast liquid is left, it is thrown away in most cases. For this contrast liquid, there are existing options from suppliers who take the leftovers of the contrast liquid back. However, Isala does not take advantage of this. A reason for this is the long-term contracts between Isala and suppliers. Hence, it is not possible to terminate the contract at every point in time. Except for the contrast liquids, Radiology is also rethinking the ultrasound gel. In the past, those ultrasound gel bottles are refilled. But nowadays, every ultrasound gel bottle is thrown away, even with leftovers, due to the hygienic rules. Radiology is also considering reducing or replacing the renal beak trays. Those trays are currently used to put in material and are thrown away afterward. The Radiology Green team looked at the opportunities to replace the renal beak trays with stainless steel material instead of paper disposables. At the Radiology, an extra MRI room is created because of the increasing demand for healthcare. Hence, there is a lack of space to separate waste since the new MRI room will occupy the former waste room.

5.2.2 Conclusion

Within Isala, implementing sustainable initiatives requires a lot of time and effort due to different reasons. First, the hospital is a big community where it takes around an average of six months before an initiative can be implemented. Second, hospitals do not want to take any risks. In addition, Isala often enters into contracts with suppliers for longer periods. From the three interviews, it turns out that healthcare workers must feel the urgency to take action in the field of sustainability. The first step is to create awareness among healthcare workers. Therefore, healthcare workers have to be informed about sustainability and its implications [26]. The interviews have shown that internal alignment and coordination is of great importance for Isala. In that case, Green teams could share ideas or make bigger decisions such as a switch to suppliers hospital-wide. However, managing waste sustainably stays difficult for the Green teams. To oversee the laws and regulations, collaboration between hospitals is required. Several sustainably initiatives formed out of the interviews with other departments within Isala are listed and are possibly useful for the HCKs:

- Creating awareness among the healthcare workers by informing them.
- Setting up a Green Team at the Heart Center.
- Rethink the amount of packaging material and align with the supplier.
- Reduce the number of cellular mats.
- Rethink refilling the contrast liquids.
- Start separating plastic hospital-wide.
- Use reusable/personalised coffee cups instead of disposables.

5.3 Waste management measures other hospitals

This Section answers Research question 4: *What initiatives on sustainable waste streams already exist in other hospitals in the Netherlands?* In order to create insight into what

other Heart Centers are undertaking about sustainable waste management, three hospitals in the Netherlands are interviewed as shown in Figure 8. The third participating hospital wants to remain anonymous.

Participants interviews hospitals		
Respondent number	Hospital	Function participant
1	Ter Gooi, Blaricum	1st nurse HCK
2	MST, Enschede	Surgery assistant
3	Hospital 3 (anonymous)	Sustainability advisor

Figure 8: Participants interviews hospitals

5.4 Results

In the past years, the Heart Center at Ter Gooi hospital in Blaricum declined the amount of residual waste from one garbage bag of residual waste to a half garbage bag of residual waste per surgery. Mainly because they separate waste into larger amounts. Firstly, the HCK at Ter Gooi is separating paper subdivided into cartons and paper with confidential information. The HCKs at Ter Gooi are also separating specific plastics, plastic foil made from polyethylene terephthalate (PETE) (RIC: 1). This type of plastic is wrapped around packaging from the HCK materials. The plastic material which is wrapped around the röntgen devices is also collected separated, together with the foil plastics. Collecting this type of plastic is free in cost, in contrast to the residual waste. At Ter Gooi, the OR started with separating plastic. After implementing it on the OR, internal alignment made it possible to do so on the HCKs. In the beginning, the healthcare workers at the HCKs think it was taking extra effort and time, but after a phase of getting used to, every healthcare worker cooperates. In the field of reducing material, the Heart Center of Ter Gooi is reconsidering the use of materials. For instance, economise the use of contrast liquids. In addition, the HCKs at Ter Gooi are reusing röntgen blankets, which are high in cost. Those blankets are under a sterile sheet. Therefore, replacing this röntgen blanket is not necessary all the time. Last year, the Heart Center of Ter Gooi came into contact with an organisation that is an expert in the field of improving the sustainability of waste streams. It was concluded that waste is separated almost optimally at the HCKs of this hospital. The only recommendation that the organisation made was about collecting more (PETE) plastics, besides the plastic foil. An opportunity was to collect PETE plastics together with four other hospitals. From those plastics, new materials could be developed such as cups or renal beak trays. However, this has never been initiated.

MST (Medisch Spectrum Twente) located in Enschede has a Heart Center combined with a Lung surgery which is called the Thorax Center. This Thorax Center aims to reduce its CO₂ emission by 5% in 2022. They have taken various measures to reach this goal of CO₂ reduction. Firstly, at the Thorax Center, they are separating cartons and paper. There is a specific room to dump and separate waste. Nowadays there is a bin for carton at the ORs and HCKs. The HCKs at the MST are also collecting pacemakers and hearth devices. In general, the Thorax Center is not separating plastics. However, during a pilot to separate several types of plastics are collected. Healthcare workers seem to be very motivated to separate the plastics, instead of depositing in the residual waste. Before the healthcare workers were informed about this pilot, they already separated the plastics by themselves. Besides that, the Thorax Center reduces the amount of small yellow boxes for sharps by informing the healthcare workers who are working at ORs and HCKs. Usually, the healthcare workers put the whole syringe in these small boxes, including the liquids.

Drug residues are deposited in special barrels. Consequently, the whole syringe is not put in the small boxes anymore, but only the needle of the syringe. This new method causes a reduction in the amount of the small boxes for sharps, and thus a waste reduction. In addition, the Thorax Center focuses on keeping its assortment of materials as small as possible. To minimise the amount of unused material, sterilised packages are suited for the type of surgery, which results in a reduction in unused material. Finally, the Thorax Center is working on reducing the number of coffee cups. They have the ambition to use personalised reusable mugs. However, a special dishwasher is needed in that case, the purchase is around €5000. The Thorax Center at MST is reconsidering this opportunity and determining how profitable it is.

The third interviewed hospital would like to remain anonymous and is called Hospital 3 in this research. Hospital 3 is doing a lot in the field of sustainability. The hospital set different targets, including responsible use and minimisation of environmentally harmful substances, embedding sustainable procurement, waste prevention, and efficient waste collection. At Hospital 3, there was a reversal in terms of sustainability. Employees felt the urgency to take action, with as a result the high amount of motivation among healthcare workers. To reduce the large number of disposables, Hospital 3 changed its procurement policy to purchasing reusable products, when possible. The purchasing department has to reconsider different disposables to allow the transition to reusable equipment. However, safety and quality of healthcare have priority when reconsidering the more sustainable option. During the Covid19 crisis, it turns out that hospitals are too dependent on disposables. According to Hospital 3 it was time for a change. This switch is communicated to all the employees. There was no question of resistance from healthcare workers. There was even demand for performing more sustainable from the employees of Hospital 3. This does not alter the fact that sustainable procurement takes more capacity, time, and effort from the procurement department. This department's decision-making, for selecting suppliers, has to change because of the big role that sustainability is playing. The regulations amongst procurement become stricter, and reusable becomes the new standard (instead of disposable). From the procurement side, Hospital 3 also conforms to different criteria including the Socially responsible procurement (SRP) and conforms to the requirements for environmental certifications. In summary, the hospital has realised many changes in the theme of sustainable procurement with reusability as the norm. This measure has been taken because reusables, over the entire life cycle, are cheaper than disposables. Moreover, the pressure on virgin materials is increasing which leads to an expectation that disposables will become more expensive in the future due to the scarcity of virgin materials and requirements from the MDR (European regulations for medical devices).

Various projects are in progress within different departments at Hospital 3, including the Heart Center. First, at the OR and HCK they are trying to use surgical instruments optimally. Thereby, they use it to prevent medication wastage. For two years, Hospital 3 aims to reduce and separate the waste. Hospital 3 started two years ago with pilots for separating plastics. After these pilots, it can be concluded that there are a lot of plastic types. However, when plastic is clean separating is possible in most cases. It is possible to separate types of plastic as PMD waste (plastic, metal, and drink cartons). Among other things, plastic packages from materials can be deposited by this type of PMD waste. Although it is not possible to separate all types of plastics, a part of it contributes to the reduction of residual waste. There are different ongoing studies, for example, research to reduce the amount of waste from infusion bags. Hospital 3 is also separating other types of waste, such as paper, glass, and coffee cups. Besides that, the HCKs are collecting types of materials that are expensive, such as catheter tips, pacemakers, and heart devices. The

ORs and HCKs are also using more sustainable alternatives for the yellow barrels with infectious waste. Normally, the whole plastic yellow barrel is incinerated. The yellow barrel is replaced by a grey barrel made from recycled plastics.

The Heart Center of Hospital 3 set up a small foundation formed by different cardiologists and technician physicians to reduce the considerable number of plastics. The vision of this organisation is that they are saving hundreds of lives each year with people with heart conditions at the Heart Center. But to achieve this, various materials are used that must comply with strict rules. One of these rules is that the products had to be packed in plastics. Through the large amount of plastic consumption, it can be ensured that the earth is becoming increasingly ill. One of the actions is collecting clean plastics and processing them into granulated by a shredder. This granulate is useful for developing new products, for example, pillboxes. By using 3D printers, the granulate can be used to make new products. Profits gained from this innovation are invested in further research. This innovative idea is still developing and still in its infancy.

5.4.1 Conclusion

According to the interviews with other hospitals, it can be concluded that every Heart Center is separating paper and cartons. In addition, every Heart Center collects heart devices and pacemakers, as well as the Heart Center of Isala. Moreover, every hospital is considering different ways to make waste streams more sustainable. The interviewed hospitals are using different methods compared to the Heart Center of Isala. A part of these initiatives is implemented hospital-wide, or in more than one department. It is therefore of great relevance to consult between the different departments of a hospital. Collaboration between departments results in internal alignment which makes it possible to implement waste management measures hospital-wide. When applying measures for sustaining the waste stream, for instance separating plastics, every employee of the hospital has to cooperate. It is also possible to communicate hospital-wide, which makes it easier to create urgency among the employees. The interviews revealed sustainable measures among the healthcare workers were well taken care of because the employees are motivated in general and need to get used to it. In some cases, healthcare workers are even asking for a more sustainable policy by themselves. According to the gathered information out of the interviews, several sustainability initiatives formed out of the interviews with other departments within Isala are listed and are possibly useful for the Heart Center with keeping Lansink's Ladder in mind [2]:

- Start separating specific plastics, such as PMD, PETE, and plastic foils (RIC: 1).
- Start to economising the use of contrast liquids or other widely used materials.
- Adapt the sterilised packages to the type of surgery.
- Use reusable coffee cups.
- Change the procurement policy by including sustainability with an increasing degree.
- Communicate hospital-wide the urgency of sustainability.
- Increase the capacity of the procurement department to invest in sustainability and reconsider a more sustainable policy.
- Include different criteria from the procurement side.
- Use recycled versions of the yellow barrels for infectious waste.

5.5 Waste management measures of companies

This Section answers Research question 5: *What initiatives to increase the sustainability of waste streams are offered by companies?* Besides Isala's Green teams and other hospitals, different organisations that offer sustainable waste management initiatives related to the healthcare sector are interviewed. Organisations can help hospitals by reducing waste or recycling materials. Because of the lack of knowledge on how to perform more sustainable, organisations may be needed which led to various pilots for hospitals [35].

Participants interviews organisations	
Respondent number	Organisation
1.	InnoMax BV
2.	Greencycl
3.	Green it Out

Figure 9: Participants interviews companies

5.5.1 Results

Innomax BV

Innomax is known as a specialist advisor in different fields of waste management. This organisation is originally from the waste industry and they want to make sure that hospitals can get a grip on their waste management policy by offering them concrete advice [37]. Innomax wants to create awareness of waste reduction. Therefore, Innomax wants to approach sustainability from the waste perspective. They emphasise two essentials: reuse of resources and choose for incineration only as the extreme option. Innomax views the various waste streams and set up a waste management plan together with the client. Besides processing waste, Innomax also advises on a hospital's procurement policy. The focus lies mainly on infectious medical waste, in the case of Isala deposited in yellow barrels. Usually, infectious waste is incinerated including the yellow barrel. Following legalisation's, it is not allowed to re-open the yellow barrels, therefore is it hard to separate this type of waste. Besides that, waste inside those yellow barrels consist of infectious material.

Innomax developed a solution to decontaminate the infectious waste and recycle it. Decontaminating waste means that all infectious substances are destroyed while preserving raw materials [37]. Different devices can decontaminate the waste streams. When decontaminating infectious waste in yellow barrels, the whole yellow barrel is shredded including the content. This creates narrow particles, through micro-waves and steam these narrow particles are disinfected. This method is similar to an autoclave. It creates normal waste after the procedure which can be separated. Usually, it is not always separated after decontaminating. After decontaminating infectious waste, it is not considered as infectious waste anymore and is classified as decontaminated waste which causes a decrease in the costs of incineration. Innomax focuses also on the part of separating and recycling this waste, after decontamination. Together with an organisation that offers decontamination devices, they are working on developing a recycling process, so their raw materials can be used as secondary materials which contributes positively to the circular economy. Currently, Innomax offers demo's to hospitals. This demo is located in Beverwijk in The Netherlands. Different types of waste can be distinguished after decontamination, for example, paper, plastics, metals, and glass. Innomax collects the yellow barrels from hospitals so that they do not have to decontaminate the waste by themselves. Thereby, Innomax makes sure that the raw materials be delivered back to raw material processors.

In conclusion, even infectious waste can be a part of the circular economy and does not have to be incinerated. The weight of a yellow barrel by itself is around 2 kg, and around 10 kg of infectious waste is deposited in such a yellow barrel. According to Innomax, decontaminating infectious waste is lower in costs than incinerating infectious waste. After decontaminating infectious waste, recycling is possible [37].

Greencycl

The second participant in the organisation interviews is Greencycl, a company, started in 2019. This organisation is on a mission to reuse or recycle materials at the end of its life cycle because the amount of hospital waste is increasing [38]. Greencycl offers four types of services: laboratory facilities, consultancy, supply & management of medical materials, and design and consulting in the field of sustainability processes. Greencycl is set up by professionals who have years of experience in healthcare who felt the urgency to start with a change. Greencycl is motivated to reduce a large amount of waste and wants to help hospitals to set the green agenda. Ultimately, the organisation wants to be able to pick up materials from hospitals that are worth recycling, for instance, polypropylene (RIC: 5), stainless steel, and other packaging materials. Greencycl wants to bring materials back into the circular chain, by making new materials out of waste which is preferably used again in hospitals. On that basis, they want to move towards complete circularity. Greencycl also advises hospitals to purchase sustainably. For example, the procurement department of a hospital could ask suppliers what they are already doing about sustainability. The procurement department could reconsider more sustainable options together with suppliers with the goal of waste reduction. However, laws and regulations have to be kept in mind. Greencycl also helps hospitals to decrease the number of instruments per intervention. When reusables are broken, the next step is repairing them instead of throwing them away. Stainless steel is also picked-up by Greencycl to create roles which new instruments can be made from. A downside of these initiatives is that it requires a lot of effort in looking at logistics, laws, and regulations. Strict rules are existing with regards to what kind of waste is allowed to be picked up and what not. Greencycl has a license to transport, collect, and process contaminated waste into raw materials. However, the initiatives from Greencycl are hard to realise in terms of laws and regulations, a license is obtained. Greencycl works together with a waste disposal company. Waste is processed at a location in the Netherlands. Some of the waste is remelted and some waste is decontaminated. Cleaned and repaired instruments are delivered back to the manufacturer, and if that is not possible, new raw materials are being made from that waste. When materials are brought back to the supplier, a CE-marking, and an MDR are required. In order to meet the laws and regulations, it cost a lot of time and money.

During the three years of existence of Greencycl, it created brand awareness and have increasingly refined the process. Currently, Greencycl has just passed the pilot phase and rented a hall to bring it to industrial size. Greencycl is partly dependent on hospitals because they have to reconsider their procurement contracts and consider if it is possible to purchase recycled materials from Greencycl. At the moment Greencycl is processing waste for around fifteen hospitals. Besides that, there is a high amount of interest in the industry. Hence, Greencycl is cooperating with different industries. Costs are playing a big role in hospitals and might be a bottleneck when it comes to sustainability. However, from 2024, a CO₂ balance has to be yielded according to the Green Deal. Greencycl has the opportunity to visualise CO₂ savings on a dashboard, to give an overview for hospitals on how much they are saving. From 2025, hospitals are obliged to pay CO₂ tax, which is collected from the healthcare budget. For example, this means that every kg of plastic that is picked-up for recycling saves around 2.6 kg of CO₂. Moreover, the costs of

CO₂ certificates are increasing in the coming years [39]. The European Union is purchasing CO₂ certificates. For every ton of CO₂ that is emitted, a CO₂ certificate is needed. Thus, what is saved at the front end and what might be a little more expensive because it is greener, is recouped through CO₂ certificates on the back end, according to Greencycl.

Green it Out

The final interviewed organisation focuses on reducing the amount of waste by offering light-weighted disposables to healthcare organisations. Green it Out does not focus on recycling or reusing, but on the reduction of waste by offering biodegradable eco-friendly alternatives to medical products [40]. These biodegradable products are greening waste streams in healthcare and reducing the pollution of the environment. Green it Out believes that contributing to sustainability does not have to be expensive, time-consuming, and difficult. Green it Out has a range of items for the healthcare sector: Protective materials (shorts and galoshes), bedding, towels, underpads, protection mats, lift sheets, and trauma sheets [40]. The products that Green it Out offers are disposables to be put on the surgery table. These products are difficult to recycle because this type of products are classified as residual waste and incinerated afterward. Recycling is not an option because the products are laminates, an upper layer of viscose bonded to a lower layer of bio-plastic. Separating and thus recycling is difficult. At the moment, Green it Out is engaged in several pilots in hospitals.

The materials the Green it Out offers are in most cases made from viscose and a barrier layer from bio-based material such as cornstarch. Green it Out offers two types of products: one with a barrier layer of bio-based material and one with a polyethylene layer. The recommended one is the more sustainable and one out of natural materials. However, both options are contributing to sustainability because they are much lighter compared to existing products, which contributes to reducing waste. The products are produced in Scandinavia. Normally, underpads for the patient in hospitals are made of cotton wool and a barrier layer made from plastics, and thus made from virgin materials. The most sustainable option offered by Green it Out is 98% made from organic material and much lighter in weight. For example, a coaster for the patient weighs 16 grams. Thus, the alternatives for disposables that Green it Out offers are smaller and less absorbing, which saves raw materials and waste. At the moment, hospitals use products that are qualified to be used broadly. Normally, the absorption capacity of medical products is high, which results in a large amount of waste. For example, some surgeries release a lot of body fluids. However, this is not the case with every surgery. It is important to reconsider if this type of fluid absorbent material is always necessary. The products from Green it Out are thus lighter in weight, although the absorption capacity then decreases, in many applications the product will still be satisfactory.

Green it Out also stands for 'true pricing', which means that they are looking at the whole supply chain of the product. This chain includes transport, raw materials, the location where the products came from, and how it is produced. For instance, viscose is a semi-synthetic fiber made from cellulose which is made from wood. The products from Green it Out is made from wood shavings from trees that already have been cut down. One of the main stories of Green it Out is that there is much more to sustain besides waste reduction. On the other side, because of the true pricing, the products of Green it Out are a little higher in cost than disposables currently used in hospitals. This is because the products are from Europe, where the prices and salaries are higher. Thereby, green energy is used in producing the products. Hence, the production process is as sustainable as possible. When the focus lies only on the costs of the products, environmental requirements

and results for waste reduction are often ignored. Thus it is hard to compare sustainable products with disposables for example from Asia, because there is a lack of insight in that process. According to Green it Out, hospitals have to be aware of the urgency of sustainability. From another perspective, health insurance manages the budgets of hospitals. Therefore, it is important that health insurance stimulates hospitals in acting more sustainable.

5.5.2 Conclusion

The three company interviews revealed that there are various types of options for reducing, reusing, or recycling in healthcare. In short, it is important to oversee the whole chain of a product. It can be concluded that the focus from the perspective of hospitals is mainly on the point of costs. Sustainable alternatives are often more expensive. But a fair price comparison between sustainable and non-sustainable products requires mapping the entire chain of a product. At the moment, there is no or less insight into the production process of disposables. For instance, producing more locally reduces transport miles. Thereby, there be good working conditions compared to Asia, where a lot of disposables came from. When comparing two products, all variables should be considered in choosing a product, not only the selling price. In addition, hospitals have to deliver a CO₂ balance in 2024 due to the signed Green Deal [11]. From 2025, hospitals are required to pay CO₂ taxes per ton of waste created. The costs of CO₂ certificates are expected to increase over the years. Although the costs of a sustainable initiative are sometimes higher does not mean that these are more expensive in the long term. Simultaneously, there is lack a of space and time to give attention to sustainability. Therefore, more capacity has to be created for this theme. In that case, there is space for looking more critically at the production process of disposables and seeing if products can be replaced with a thinner or reusable product. Several sustainability initiatives formed by the interviewed companies are listed and are possibly useful for the Heart Center or Isala-wide:

- Create more capacity and time for the procurement department to critically rethink and get insights into production processes from suppliers and reconsider more sustainable alternatives.
- Get advice on sustainable waste management from organisations that are experienced in the waste industry and healthcare.
- Get advice on sustainable procurement from an experienced organisation in waste management and healthcare.
- Reconsidering the infectious waste in the yellow barrels and think of options to decontaminate and recycle this type of waste subcontracted to an organisation.
- Have an organisation collect waste from the hospital for recycling, e.g. types of plastics.
- Set requirements for suppliers in the process of sustainable procurement.
- Outsource repairing reusables by a company instead of throwing broken materials immediately away.
- Consider biodegradable and environmentally-friendly alternatives for disposables that are lighter in weight.

6 Key performance indicators

To safeguard the economic, social, and environmental aspects, a multi-criteria decision-making method for medical waste often requires a hierarchical structure [24]. This Chapter provides an answer to Research question 6: *What KPIs are important in measuring the usefulness of an initiative for the Heart Center?* Different KPIs can be used for measuring the effect of waste management initiatives. When implementing a waste management initiative, there should be an impact on CO₂ and the amount in waste. Section 6.1 describes the environmental KPIs. Subsequently, Section 6.2 clarifies the social dimension of the KPIs. Then, the economic KPIs are described in Section 6.3. Finally, Section 6.4 gives an overview and advice on developing a dashboard with the selected KPIs.

6.1 Environmental

The core of the sustainability dimension is the environment [41]. Organisations, and thus hospitals can benefit from paying attention to the working environment [41]. KPIs that measure the aspect of the environment in the field of CO₂ emissions, renewable resources, consumption, and amount of waste is described [41]. These KPIs are about fighting climate change and are widely applicable. In the case of testing the effect of waste management initiatives within Isala or at the Heart Center, several KPIs found in literature can be used [24]. Organisations are offering methods to hospitals to show the CO₂ effect of sustainable initiative. Different KPIs are found in literature to measure the improvement of the use of renewable, gas emissions, waste, and resource consumption [41]. Possible environmental KPIs for the Heart Center of Isala are as follows:

- CO₂ rate
- Renewable energy rate
- Rate of waste generated per thousand product units
- Waste reduction rate
- % of hazardous waste over the total waste
- % of recycled/reused material over total materials

6.2 Social

The social dimensions know different stakeholders who are involved in implementing sustainable initiatives [42]. According to Husgafvel, there is empirical evidence on the value-creating impact on safety, health, and a social sustainability rate [43]. When implementing sustainable measures, the employee's acceptance of organisational change has to be included [41]. Suitable social KPIs for the Heart Center and Isala-wide are listed:

- Employee satisfaction rate
- Rate of employees that are involved with sustainability
- Number of training hours per employee
- Support employee rate (physical activities, health, room for ideas)
- Internal relation rate
- Health and safety rate
- The number of disciplinary actions

6.3 Economic

The last key dimension is the economic dimension [18]. Due to the fact that costs are playing a big role in the healthcare sector, economic KPIs have to be included when determining the economic effect of a sustainable measure [24]. In most cases, the more sustainable option seems to be more expensive. However, when critically evaluating the production process of the less sustainable option, it appears that sustainable gained more profits in the long-term. The economic KPIs are meant to increase the return of investments, increase revenues associated by sustainable dimensions, enhance the technology process and guarantee the quality of the processes [41]. The selected KPIs are mainly usable hospital-wide. Many of them are part of the procurement department of Isala because suppliers are highly involved. Suitable KPIs for the Heart Center of Isala wide from the economic perspective is as follows:

- Total costs of investment relating to environmental protection.
- Environmental costs savings
- Environmental penalties (from 2025)
- % of income from recycling or reusing programs
- Sustainable innovation rate
- Response to environmental programs rate (for suppliers)
- Amount of environmentally save alternatives
- % of the products with environmental classifications e.g. CE-certificating, MDR, ISO (International Organization for Standardization)
- Environmental information accuracy rate
- Environmental information availability rate

6.4 KPIs Dashboard

To oversee the numbers in waste reduction or the number of reused/recycled material, a dashboard could be created. A dashboard can visualise a hospital's data and can show information about a hospital's sustainable performance, for instance, the amount of recycled products or the reduction in materials. However, the effect of sustainable measures from the Heart Center are not available until they are implemented. Thus, after implementing the recommended sustainable measures, it is optional to create a dashboard where KPIs are visualised. At the moment, the procurement department of Isala has developed a dashboard for the existing Green Teams to show the reduction in disposable material over time as shown in Figure 10. This figure shows the number of used drop cloths at the OR of Isala.

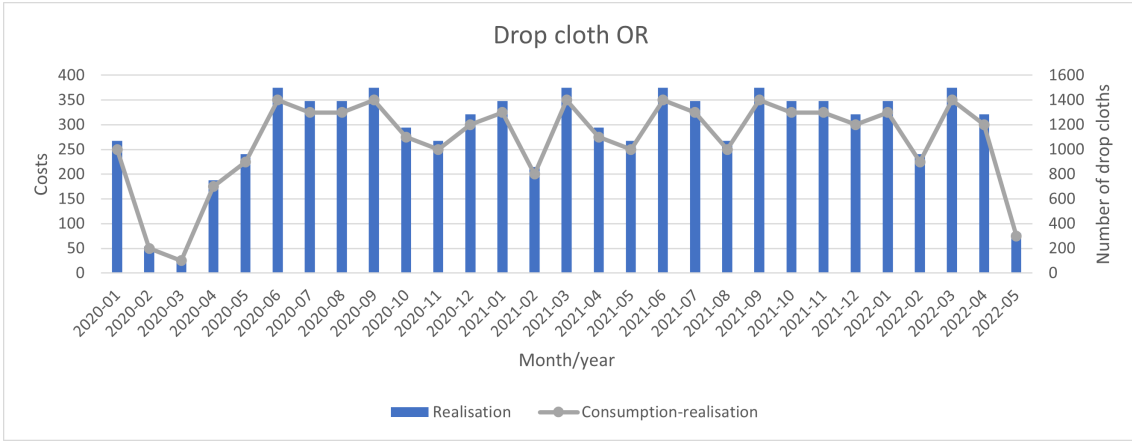


Figure 10: Dashboard Green Team OR

Because of the fact that there is not yet data available on the effects of the waste management initiatives, it is not possible to develop a dashboard. However, a prototype can be developed with fictitious numbers as follow-up research. Tableau is a possible tool to develop dashboards to analyse data and thus a possible option to use to visualise sustainable data [44]. According to the various KPIs earlier in this chapter, a few of them are selected to measure sustainable initiatives from the environmental, social en economic perspective most suited for the Heart Center as shown in Figure 11.

Perspective	KPI	Measurement
Environmental	Waste reduction rate	% of waste per 1000 products this year compared to previous year
	CO ₂ rate	CO ₂ that products emits during use per 1000 product units
	% reused/recycled material	Recycled material used\total material
	% of hazardous waste over total waste	Infectious waste (hazardous waste) / total waste
Social	Employee satisfaction rate	% of satisfied employees
	Rate of employees that are involved with sustainability	Involved employees / total employees
	Number of training hours per employee	Total training hours/ total employees
Economic	Investments in environmental protection	Investments in environmental technology / total investments
	Income from recycling/reusing	Savings from recycled material instead of virgin materials
	Products with environmental classification	% of the products with environmental classifications
	Environmental information availability from suppliers	% of environmental information availability from suppliers

Figure 11: KPIs Heart Center

7 Recommendations

This chapter describes recommendations for waste management at the Heart Center of Isala and provides an answer to research question 7: *What are the most suited waste management initiatives for the Heart Center?* First, there are a few general recommendations in Section 7.1 who are applicable hospital-wide or at more departments than only the Heart Center. Secondly, Section 7.2 describes the priority in Lansink’s Ladder, recommendations for the reduction or prevention of waste [2]. Section 7.3 advises on reusing and recycling. Section 7.4 includes recommendations for separating waste. Finally, Section 7.5 describes the recommendations for sustainable procurement.

7.1 General recommendations

Although the focus of this paper lies on the Heart Center, some recommendations are aimed hospital-wide or are applicable for more departments. Recommendations that are meant for the Heart Center, are possibly also applicable for other departments such as the OR or other surgical departments.

Create awareness among the employees of Isala: As a first step, employees have to be aware of the urgency and the consequences of the high amount of CO₂. A lot of healthcare workers seem to be motivated, but there might be a lack of knowledge on how to implement sustainable initiatives among employees. Staff working on HCKs are not educated on greening and safety benefits for waste reduction [45]. A first step could be a campaign or a course for employees to learn more about sustainability and its consequences. Recommended is the implementation of educational programs for employees within Isala. These programs are meant to create awareness and inform them about the measures that will be implemented.

Develop a Green team for the Heart Center: Clear communication between departments and Isala-wide is of great importance to realise sustainable goals. When awareness among the healthcare workers is created, a Green team for the Heart Center can be developed. This Green team exists out of involved employees who want to contribute to sustainability. This Green team will launch the improvement of sustainability at the Heart Center.

More communication about sustainability within Isala: More communication is needed between the Green teams, the procurement department, and in general, hospital-wide. Successful sustainable waste management in a hospital depends on the management team, administration, planning, underpinning legislation, financing, and full participation from healthcare workers [46]. For example, a standardised process for implementing sustainable initiatives could be developed which clarifies the steps that have to be followed. Hereby, a standard procedure can be created for switching to a reusable product instead of disposable where all parties are involved. Accordingly, waste management protocols must be convenient and realistic.

Develop a dashboard for measuring the effects of sustainable actions: When sustainable measures are implemented, it is desirable to determine the effects and their contribution to CO₂ reduction. A dashboard with selected KPIs is shown in Figure 11. A recommendation is to develop a hospital-wide dashboard, where data from each department can be viewed. However, further research is needed to develop a dashboard.

7.2 Reducing waste

The reduction or the prevention of waste is the first goal of Lansink's Ladder [2]. Hence, several recommendations are made with the purpose waste reduction. Reusing or recycling, Section 7.3, is also contributing to a reduction in waste. Different options are possible to reduce or prevent the amount of waste.

Get advice on sustainable waste management from organisations that are experienced in the waste industry and healthcare: Sustainable waste management is very complex and requires a multidisciplinary approach. Owing to the increasing demand for care, workload increases as well. It is therefore likely that hospitals experience a shortage of capacity to include sustainability into daily operations.

Rethink the number of disposables: Different materials can be reconsidered if the amounts of the disposable version is actual necessary. An example is the cellular mats. In other departments, these cellular mats are decreased, which causes waste reduction. It can be critically considered when it is necessary to throw away a cellular mat. Usually, a cellular mat is placed on a table or trolley where loose products are placed [28]. Often these products do not come into contact with the mat, but only with the cup or tray. It can be considered to reuse the cellulose mat for the next patient if this is permitted by infection prevention. Excluding the cellular mats, other materials used in the HCK could also be reconsidered, such as underlays for the patient. The Heart Center of Isala is using 5% of the underlays for patients, the other 95% is used by the other departments of Isala. Although this is not a high percentage, it can already make a difference.

Consider biodegradable and environmentally-friendly alternatives for disposables that are lighter in weight: When reusing is not an option due to the fact of the infectious risks, a switch to biodegradable materials can be considered. Biodegradable materials are not made from plastics and have lower a CO₂ footprint [28]. During the production of biodegradable materials, there are fewer CO₂ emissions released than in the production process of plastics. In general, there are better working conditions and the transport miles are less.

7.3 Reuse and recycle

The second and third priority on the Ladder of Lansink is reusing and recycling [2]. Therefore, several recommendations are made. The interview data and literature show that there are a lot of opportunities concerning reusing and recycling [31].

A switch from disposables to reusables: A reusable generally causes fewer emissions than a disposable [14]. A transition to more reusables instead of disposables would definitely results in a gain in sustainability. Capacity has to be created to consider reusable options instead of disposable ones. It could be profitable to look at the recycling potential of disposables. In that case, the current processes of production have to be critically reviewed by the procurement department of Isala. Optionally, contracts with suppliers could be reconsidered and opportunities for the collection of used material contribute positively to sustainability. For example, suppliers could collect leftover material or waste. In consultation with suppliers, examine whether it is possible to make agreements on the return and recycling of the waste. When a transfer is made to reusables, more capacity is needed from the central sterilisation department. This must be taken into account.

Start using personalised and reusable coffee cups: Even though coffee cups sound like a small difference, the residual waste consists on an average of 4% of coffee cups [3]. Reusable personalised coffee cups will require an extra investment but will be profitable for waste reduction in the long term. The abolishing of disposable and non-recycled coffee cups should be implemented Isala-wide.

Start to economise the use of contrast liquids or other widely used materials: Leftovers are normally thrown away. The Heart Center can rethink the amount of material that can contribute to the reduction in material. For instance, contrast liquids, such as the Radiology department at Isala. Together with the suppliers, an agreement can be made to taking back several types of material or liquids that are commonly used at the Heart Center.

Have an organisation collect waste from the hospital for recycling, e.g. types of plastics: Recycling should be included as part of improving the sustainability of a hospital. Recycling will cause a waste reduction. Except for the reduction of waste, less toxic products are produced which improves energy efficiency [47]. Different research shows that recycling has a high potential in surgery rooms, and thus for HCKs [47]. This recycling process can be outsourced to an organisation.

Use recycled versions of the yellow barrels for infectious waste: The interviewed hospitals showed that the infectious waste is commonly deposited recycled grey coloured barrels. In 2018, five pilots have started with recycled barrels for infectious waste. By using these drums, CO₂ emissions are reduced by more than 50% compared to drums made of virgin materials [48]. The recycled infectious waste barrel complies with every requirement for the storage and transport of dangerous substances. Moreover, the recycled barrels are certified by ISO and succeed in different tests. Recycling containers eliminates the need for natural resources [45]. A recommendation is to deepen this opportunity and see if it is feasible for Isala.

Reconsidering the infectious waste in the yellow barrels and think of options to decontaminate and recycle this type of waste subcontracted to an organisation: Excluding the recycled barrels for infectious waste, it can also be considered to decontaminate the infectious waste. The decontamination of waste is outsourced to a company. After decontaminating, it is possible to separate waste or even to recycle. At the moment, pilots are in progress in the Netherlands. It is therefore recommended to the Heart Center to participate in a pilot where infectious waste results in normal waste for separation or recycling.

Outsource repairing reusables by a company instead of throwing broken materials immediately away: When reusables are busted, ordinarily, it is thrown away. The Heart Center could consider delivering broken reusables to a company that can repair them. A few companies deliver this service to hospitals. Excluding the Heart Center, this recommendation can be implemented hospital-wide.

7.4 Separating waste

The need for separating more waste was high at the Heart Center. An outcome of this study is the flowchart for waste management as shown in Figure 12. This flowchart provides a visualised waste management plan for the Heart Center, where the green boxes show the sustainable initiatives. The other colours refer to the different waste streams.

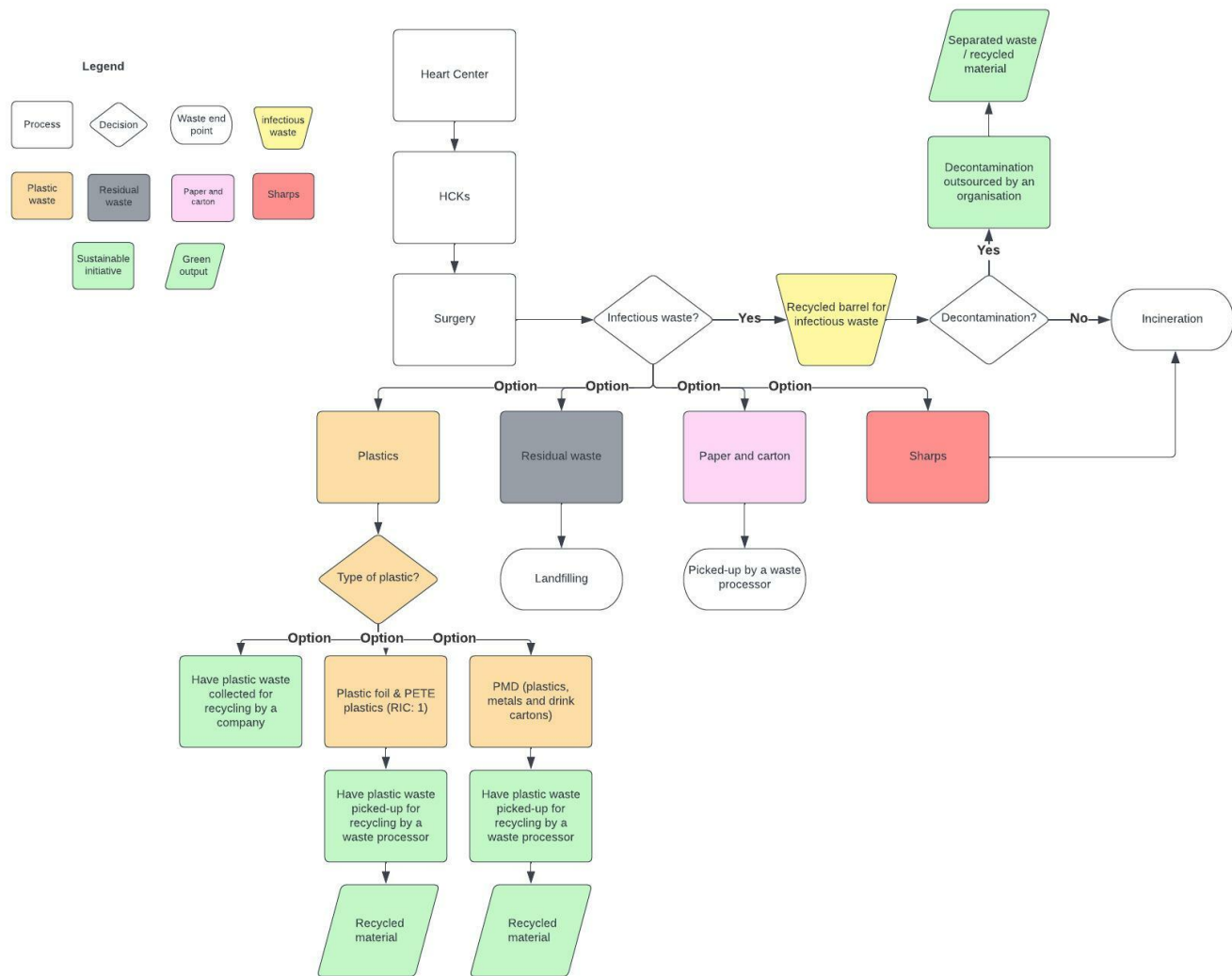


Figure 12: Flowchart waste management

Start separating specific plastics, such as PMD, PETE, and plastic foils (RIC:1): Many studies have demonstrated a reduction in surgical waste through waste initiatives focusing on the separation of waste and recyclable items such as plastic [17], [31]. Therefore, it would be desirable to separate types of plastics such as PETE (RIC:1) and PS (RIC:6). By using RIC codes at the HCKs, the waste collection process can be explained. A table with types of plastic can be represented to healthcare workers. Although cartons and paper are already being separated at the Heart Center, plastic is not. It is recommended to have an extra waste unit with an orange bag for plastics in every HCK room. These waste units have wheels under them, to make it possible to move the waste units due to the lack of space on the HCKs. A first step for the Heart Center is to start with measuring the different types of plastics in the department. Afterwards, the highest proportion can be addressed by starting a pilot with separating plastic.

7.5 Sustainable procurement

The procurement department plays a significant role in the procurement process of a hospital. Several measures have to be taken when realising the increase in sustainable procurement. Therefore, recommendations are made for the procurement department of Isala.

Rethink the amount of packaging material and align with the supplier: Currently, there are large numbers of packaging materials. A recommendation is to reconsider the way of packaging in consultation with the supplier. Besides the awareness of healthcare workers, suppliers also play a big role. An agreement must be concluded to involve the supplier into the urgency to increase the sustainability of a hospital. The contracts with the suppliers must include a sustainable aspect, and suppliers who are using less packaging material or contribute to sustainability should be given priority. However, more capacity is needed to oversee the opportunities with suppliers and sustainability. The purchasing department should have more capacity to include this aspect into the standard process. For example, an agreement with the supplier can be developed on returning packaging materials or leftovers.

Change the procurement policy by including sustainability to an increasing degree: Involve suppliers in the process of sustainable procurement and make arrangements. To achieve participation from the suppliers, changes in the procurement policy potentially have to be made. Hospitals can gain much when it comes to formulating the right sustainable questions for the supplier. There are different ways to implement sustainability in the policy of Isala. For example, obligatory suppliers to provide insights in the production process and their contribution to sustainability.

Increase the capacity of the procurement department to invest in sustainability and reconsider a more sustainable policy: When the process of materials for Isala is critically reconsidered by the procurement department, extra capacity is needed. The procurement department has a major role in the provision of all the materials and devices for Isala. As a result, there is a lack of time to critically rethink processes of material and see if more sustainable options with suppliers are possible. It is essential to engage with the suppliers who can be encouraged to develop for example innovative solutions [49]. The recommendation is to increase the capacity and make room for investment in sustainability. For example, a new position can be created who is fulfilling the role of a sustainability coordinator or a policy advisor on sustainability. A package with requirements and wishes could be developed for the supplier. In addition, more training and education are profitable to employees, to compensate for the lack of knowledge on life-cycles and sustainable procurement. A course could be provided to employees of the procurement department to create insights on green purchasing.

Get advice on sustainable procurement from an experienced organisation in waste management and healthcare: Of course, creating extra capacity for sustainability within Isala is not taken for granted in any case. However, there are several organisations that are experienced in sustainable procurement in the healthcare sector. Hence, it is possible to receive advice from an experienced organisation. In this case, help is provided and it is partly outsourced whereby the lack of time is not a bottleneck anymore. Organisations can deliver advice to Isala on how sustainable procurement is possible, including their current policy, laws, and regulations. Another option is further research on sustainable procurement, which provides insights into the current procurement process and adjustments that are causing a more green procurement process.

8 Conclusion & Discussion

This research is conducted to formulate an answer to the research question:

To what extent can the waste streams at the HCKs of Isala’s Heart Center in Zwolle be made more sustainable?”

To answer this research question, a whole procedure has been gone through. Section 8.1 provides the answers to the sub-questions. Consequently, the main research question is answered in Section 8.2. Section 8.3 describes the discussion part of this research. After which the limitations are discussed in Section 8.4. Finally, Section 8.5 recommends future research on this topic.

8.1 Answering the research questions

Data is gathered from interviews and literature and is analysed. There is a lack of knowledge on how to handle the large amounts of waste at the HCKs at the Heart Center, divided into infectious waste, sharps, paper, and residual waste. Literature shows that residual waste in hospitals contains large numbers of plastic, which is potentially suitable for recycling. Due to the large variety of types of plastic, it is not being separated and recycled yet at the Heart Center of Isala Zwolle.

Literature research offers a broad overview of sustainability in hospitals. Currently, there is no research carried out in specific for the Heart Center, but studies for ORs are also applicable to HCKs because both are a type of surgery room. The literature recommends different environment-friendly practices such as waste reduction, waste separation, reuse of materials, and recycling of materials. The advantages of recycled material are promoted in different literature. Moreover, adopting policies and standardised procedures for sustainable waste management is much talked about in literature, for example, separating types of plastic. Lastly, literature shows that cooperation with the supplier and reconsidering the reuse of material contributes positively to sustainability in hospitals. This broad overview of the literature is examined in more detail during the interviews. First, it is important to create awareness among healthcare workers. Second, a green team for the Heart Center can be developed. According to the interviews within Isala, it becomes clear that a lot of materials can be reduced. Some waste management initiatives are only applicable hospital-wide, for example separating waste. Rethinking the number of materials and cooperation with the supplier also appears here.

Heart Centers from other hospitals are also considering different ways to act more green. Collaboration between departments of the hospital is valuable for sharing initiatives and implementing several initiatives hospital-wide. From the side of the companies, the most important aspect is to oversee the whole chain of a product, even though sustainable options are more expensive in the first place. Hospitals focus mainly on the economic aspect but the production process of disposables is not always viewed critically. Thereby, in some cases, there is a lack of capacity to give attention to sustainability. Nowadays, several companies are offering services for sustainable waste management. Besides advising hospitals, some companies offer techniques for recycling plastics, infectious waste, and lighter biodegradable disposables.

When measuring the effect of an implemented sustainable initiative, KPIs are selected from the literature from a social, economic, and environmental perspective. The most suited are listed and can be visualised in a dashboard in the future when Isala has data

from sustainable initiatives that are implemented. Healthcare workers appear to be motivated to reduce the large numbers of waste according to the interviews and literature. Currently, healthcare workers ask themselves for initiatives for reducing or separating waste. However, implementing measures require a different working process from the healthcare workers. Therefore, healthcare workers have to be informed and involved in the topic of sustainability. Active participation of healthcare workers will contribute to the improvement of sustainability and the reduction of waste on HCKs.

8.2 Answering the main research question

The main research question: *To what extent can the waste streams at the HCKs of Isala's Heart Center in Zwolle be made more sustainable?* is answered.

It can be concluded that the waste stream at the HCKs of Isala's Heart Center can certainly be sustained. The potential for improving the sustainability of waste streams is high. Different methods can cause a reduction in the amount of waste. There are a lot of opportunities to reduce, reuse or recycle materials. To achieve this, the Heart Center and Isala has to make considered choices to take action and create capacity for sustainability. The first step is to develop a Green team for the Heart Center. From the procurement side, aligning with the supplier and adapting the procurement policy by involving the green topic can cause a major difference. Thereby, separating plastic causes a reduction in the large amounts of residual waste, and results in an opportunity for recycling. Due to the limited capacity, multiple organisations in the Netherlands are offering pilots and services to hospitals. Outsourcing sustainability advice and waste management services to organisations allow hospitals to focus on their area of expertise: providing professional healthcare.

It is desirable that sustainable waste management initiatives are broadly applicable in hospitals. Stakeholders have to collaborate to achieve the transition to a circular economy. At the managerial level of hospitals, sustainability is something that comes on top. Next to hospitals, several parties will have to contribute such as health insurance, suppliers, and the government. From the perspective of the government, they have to make incinerated waste less attractive. On the other side, reducing, recycling, and reusing have to be made more attractive and rewarded. Another important aspect is the need for collaboration between Dutch hospitals. Currently, every hospital is researching by themselves measures to reduce the amount of CO₂ and thus the fulfilment of the signed Green Deal. Isala could reduce the total cost of treatment and disposal of medical waste when improving its classification of waste. By careful exclusion of infectious and non-infectious waste streams, Isala can reduce the high volume of waste that requires special treatment such as incineration or landfilling.

8.3 Discussion

This study revealed a lack of knowledge in the Heart Center at Isala regarding making waste streams more sustainable. This is applicable for different areas such as separating waste, reducing waste, or recycling waste. From the side of behaviour, healthcare workers must initiate and support efforts to implement waste management initiatives. Initially, green alternatives seem to be more expensive. However, in most cases, there is no attention to the entire chain of a product, only the selling price. When considering sustainable initiatives, other factors have to be taken into account, such as transport or the increasing costs of CO₂ certificates in the future. In brief, the whole chain of a product and sustainable alternatives have to be viewed critically to determine the fair price. Addi-

tionally, a collaboration between different parties has a major impact. For instance, the collaboration between hospitals contributes to a standard approach for reducing waste or introducing green products. Besides that, stimulation from the government and health insurers is required to succeed in this sustaining process. Moreover, suppliers play a big role in sustaining hospitals which means that agreements can be made between those two parties.

8.4 Limitations

This research is performed as a graduation assignment for the Bachelor Health Sciences. As a result, there is limited time available. Therefore, it was for example not possible to identify types of plastic waste at the HCKs. Interviewing more hospitals and companies was not possible due to time constraints. Secondly, it was hard to get in contact with hospitals for this research. Not every hospital was willing to share the ideas and initiatives on sustainability for research. A reason for this is hard to determine, but must be treated with respect. Moreover, laws and regulations are playing a big role in sustaining hospitals. In this research, it is not specially addressed. When implementing sustainable measures, it is of great importance to include these laws and regulations which requires future research. No account has been taken off for rules from the municipality and the waste processor. However, rules for waste management differ per municipality and waste processor. For example, hospitals can have agreed with the waste processor and municipality for the free collection of plastic. It is plausible that this is not applicable in every municipality. Lastly, because no sustainable initiative is implemented yet, it is not possible to calculate the effect. Literature-based predictions were not available which results in no available data for measuring the effects of sustainable initiatives.

8.5 Future research

Sustainability in hospitals remains a hot topic in the future which means that there are several options in future research possible. In particular, for the Heart Center, the residual waste could be identified in future research. Hereby, the types of plastic according to the RIC can be identified as codes [29]. After identifying those plastic types, separating and recycling are the next steps. From the perspective of the procurement department, future research is possible to create a standard procedure for suppliers where sustainability is included. Different criteria for sustainable procurement have to be researched and selected for Isala. To visualise results after implementing green initiatives, future research for a dashboard is also an option. A dashboard could be developed to see the effect of sustainable measures using the selected KPIs. Finally, future research is possible when it comes to laws and regulations. Laws and regulations that play a part in sustainable initiatives or restrict them, can be identified in future research.

To conclude, the sustainability of waste streams in hospitals will remain a hot topic. Hence, more research on this topic is expected. To succeed in the fulfilment of the Green Deal, it is not an option to stay behind for Isala in terms of sustainability. The potential is high, but every stakeholder has to cooperate, both internally and externally. This research offers insights into the numerous sustainable initiatives suitable for hospitals. Although the opportunities are high, it is up to Isala to take action and implement those recommendations for sustainable waste management, with as a first step, developing a Green team for the Heart Center.

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Appendices

Appendix A: Stakeholder analysis

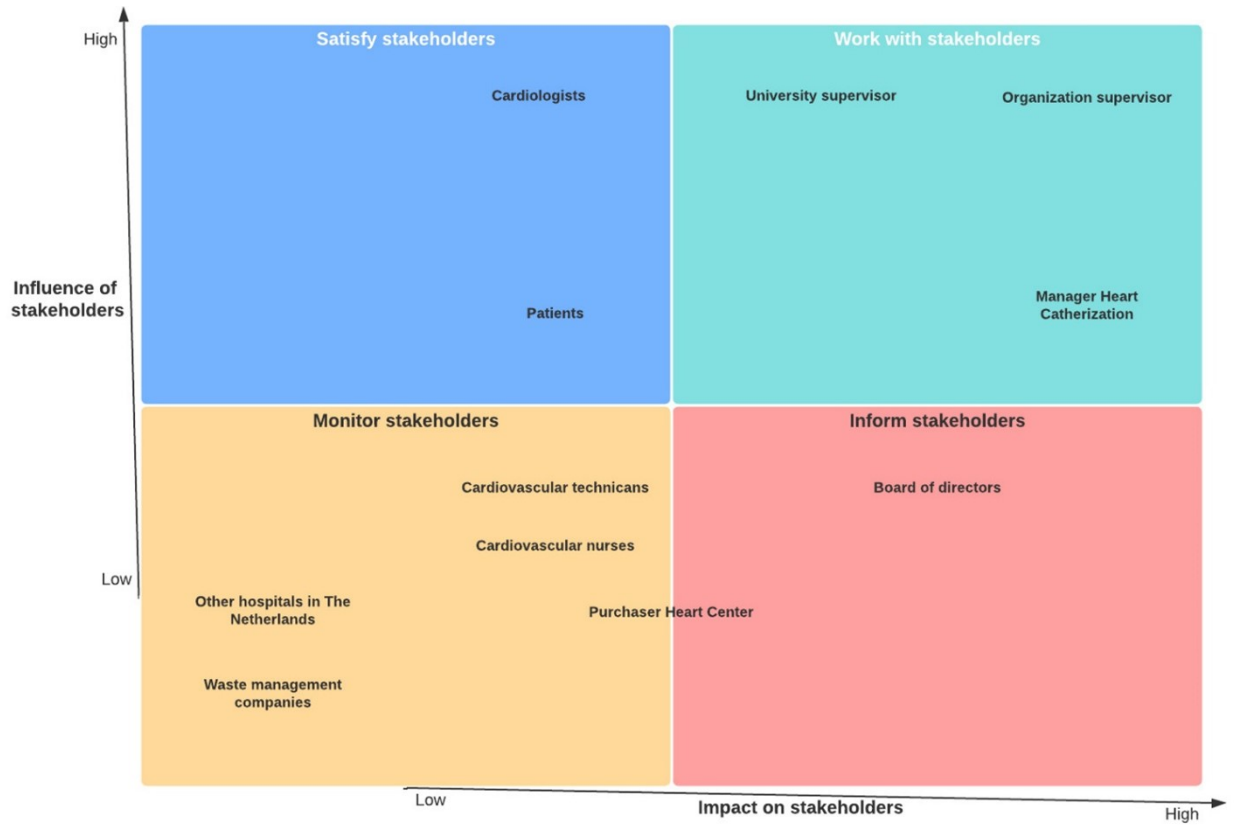


Figure 13: Stakeholder analysis

Appendix B: Overview research design

Research question	Type of research	Research population	Subjects	Research strategy	Method of data gathering	Method of data processing	Activities
1. What is the current situation of waste flows at the HCKs?	Descriptive.	Isala.	Current situation heart catheterization rooms (HCKs).	Deep qualitative.	Direct process (unstructured) observation.	Description and visual representation. Qualitative.	Observe process, overview process.
2. What initiatives about the sustainability of waste streams can be found in the literature?	Descriptive.	Literature.	Initiatives for sustainable waste management in the literature.	Broad qualitative.	Literature study (cross-sectional).	List of initiatives for sustainable waste management from the literature.	Literature research, choose potential initiatives, describe potential initiatives.
3. What initiatives are already in place within Isala to make the waste streams more sustainable?	Descriptive.	Other departments at the Isala (Operating room, clinical pharmacy, radiology).	Initiatives for sustainable waste management within Isala.	Deep qualitative.	Communication.	List of initiatives for sustainable waste management within Isala at other departments.	Three semi-structured interviews, describe potential initiatives.
4. What initiatives on sustainable waste streams already exist in other hospitals in the Netherlands?	Descriptive.	Other hospitals in the Netherlands (Radboud, MST, MCL).	Initiatives for sustainable waste management at other hospitals.	Deep qualitative.	Communication.	List of initiatives for sustainable waste management at other hospitals.	Three semi-structured interviews, describe potential initiatives.
5. What initiatives to increase the sustainability of waste streams are offered by companies?	Descriptive.	Companies (Vanguard, Van Straten Medical, Hartplastics)	Initiatives for sustainable waste management that are offered by companies.	Deep qualitative.	Communication.	Description of initiatives for sustainable waste management from companies.	Three semi-structured interviews, literature research, describe potential initiatives.
6. What KPIs are important in measuring the usefulness of an initiative for the Heart Center?	Explanatory.	Literature, Isala.	KPIs, problem owner	Deep qualitative.	Literature study (cross-sectional) and communication	Selection and explanation of the most useful KPIs for measuring the value of a waste management initiative.	Literature research. Overview KPIs.
7. What are the most suited waste management initiatives for the Heart Center according to the selected KPIs?	Explanatory.	Isala.	Most suited waste management initiatives, problem owner.	Deep qualitative.	Answers to other questions (cross-sectional)	Evaluating the selected waste management initiatives utilizing KPIs (usability analysis).	Evaluate, explain selection.
8. To what extent does the behavior of health care workers play a role in making waste management more sustainable?	Descriptive.	Literature	The behavior of health care workers	Broad qualitative.	Literature study (cross-sectional).	Description of the behavior of care workers within the process of sustaining the waste stream.	Literature research, recommendation to implement waste management initiatives.

Figure 14: Overview Research Design

Appendix C: Interview schedule Isala & other hospitals

Interview schedule Isala & other hospitals

Introduction

Thank you for participating in this interview. My name is Delphi den Riet and I am a Health Sciences student at the University of Twente. The title of the thesis is: Improving the sustainability of waste streams at the Heart Center of Isala Hospital in Zwolle. This interview is about sustainability initiatives around waste management in hospitals, with the aim of creating insight into what other departments of Isala, other hospitals and companies are doing in the field of sustainability in healthcare.

Purpose

The focus here is primarily on improving the sustainability of waste streams, or waste management initiatives. Thus, the purpose of this interview is to gain insight into existing sustainability initiatives and how other parties are dealing with this topic.

Confidentiality

An information letter and signed informed consent is sent in advance and signed before the interview begins. If desired, anonymity will be fully guaranteed. The interview will be recorded using an audio recording if permission is given. Recordings provide a more accurate result for drawing conclusions. In addition to recordings, notes may be taken. The collected data will be carefully stored and processed. Recordings are deleted within two days, when the interview is transcribed. The collected information is processed in a

report. Personal data will be processed anonymously in the report, if desired. Names will only be mentioned in quotes if permission has been given in the signed informed consent.

Preconditions

It is a semi-structured interview. Stopping the interview is allowed at any time, not every question needs to be answered. Various topics are discussed during the interview. You are always welcome to ask questions or add (relevant) topics yourself. These topics are all within the theme of sustainability around waste management initiatives. Before we begin, do you have any questions of your own?

Position interviewee:

Hospital/department:

Date:

Core

Starting question:

Can you tell something about what role the topic of sustainability plays in your daily work?

Topic list

1. Sustainability in general: sustainability is an increasingly 'hot topic' in the health-care sector. The number of initiatives is growing, and this is also of great importance.

Current situation

Are you aware of the current development around sustainability in healthcare/hospitals?

Sustainable initiatives

What is already being undertaken in your department around the theme of sustainability?

Types of waste

What types of waste are there in your department?

How is waste handled in your department?

Separation of waste

How is waste separated in your department?

2. Ladder of lansink: a tool for waste management, is the ladder of Lansink^[2]. This tool offers waste management hierarchy and ways to handle waste which are prioritised. The keynote of the Lansink's ladder is that separation at the source is preferable to separating afterwards. And reusing is better than recycling. In this part of the interview, the three R's are reviewed.

Refuse

Are there actions taken in your department to refuse/not to accept certain waste? If so, which ones?

Reduce

Are any actions taken in your department to reduce waste, if so, which ones?

Reuse

Are any actions taken in your department to reuse material/waste? If so, what actions?

Recycle

Are any actions taken in your department to recycle material/waste? If so, what actions?

3. Waste management: the third part of the interview serves as a conclusion of previous part and deals with how waste is handled.

Separating waste

How is waste separated in your department?

Reducing waste

In what way does your department contribute to reducing waste?

Manufacturers

In what ways do manufacturers play a role within the waste streams? (e.g., the way of packaging materials)

Points of improvement

In your opinion, what are improvement points for sustainable waste management?

4. Laws and regulations: in sustainability initiatives, laws and regulations can play a role. This section of the interview briefly explores this theme.

In what way do laws and regulations play a role in sustainable waste management initiatives in healthcare?

5. Care workers: the final section discusses the behaviour of care workers.

Waste management

How does healthcare personnel deal with rules around waste management?

Is there resistance or cooperation of care workers when it comes to sustainability?

Change management

What is the role of care staff in a department when sustainable (waste) measures are implemented?

End

- Summarising interview
 - Do you have anything to add/ask yourself?
 - Are there any topics that were not sufficiently covered?
- Feedback of results
- Informed consent
- Thank you

Appendix D: Interview schedule companies

Interview schedule companies

Introduction

Thank you for participating in this interview. My name is Delphi den Riet and I am a Health Sciences student at the University of Twente. The title of the thesis is: Improving the sustainability of waste streams at the Heart Center of Isala Hospital in Zwolle. This interview is about sustainability initiatives around waste management in hospitals, with the aim of creating insight into what other departments of Isala, other hospitals and companies are doing in the field of sustainability in healthcare.

Purpose

The focus here is primarily on improving the sustainability of waste streams, or waste management initiatives. Thus, the purpose of this interview is to gain insight into existing sustainability initiatives and how other parties are dealing with this topic.

Confidentiality

An information letter and signed informed consent is sent in advance and signed before the interview begins. If desired, anonymity will be fully guaranteed. The interview will be recorded using an audio recording if permission is given. Recordings provide a more accurate result for drawing conclusions. In addition to recordings, notes may be taken. The collected data will be carefully stored and processed. Recordings are deleted within two days, when the interview is transcribed. The collected information is processed in a report. Personal data will be processed anonymously in the report, if desired. Names will only be mentioned in quotes if permission has been given in the signed informed consent.

Preconditions

It is a semi-structured interview. Stopping the interview is allowed at any time, not every question needs to be answered. Various topics are discussed during the interview. You are always welcome to ask questions or add (relevant) topics yourself. These topics are all within the theme of sustainability around waste management initiatives. Before we begin, do you have any questions of your own?

Position interviewee:

Organisation:

Date:

Core

Starting question:

Can you tell something about what role the topic of sustainability plays in your daily work?

Topic list

1. Sustainability in general: sustainability is an increasingly 'hot topic' in the healthcare sector. The number of initiatives is growing, and this is also of great importance.

Current situation

Are you aware of the current development around sustainability in healthcare/hospitals?

Sustainable initiatives

Can you tell something about what your companies offers to hospitals?

2. Ladder of lansink: a tool for waste management, is the ladder of Lansink[2]. This tool offers waste management hierarchy and ways to handle waste which are prioritised. The keynote of the Lansink's ladder is that separation at the source is preferable to separating afterward. And reusing is better than recycling. In this part of the interview, the three R's are reviewed.

Reduce

Are there any ways to reduce waste according to (company name), if so, which ones?

Reuse

Are there any ways to reuse material according to (company name), if so, what actions?

Recycle

Are any actions taken according to (company name) to recycle materials/waste? If so, what actions?

3. Waste management: the third part of the interview serves as a conclusion of the previous part and deals with how waste is handled.

Separating waste

How do the sustainable initiatives from (company name) contribute to separating waste?

Manufacturers

In what ways do you think manufacturers play a role within the waste streams? (e.g., the way of packaging materials)

Points of improvement

In your opinion, what are improvement points for sustainable waste management in hospitals?

To what extent do costs play a role when implementing waste management initiatives?

4. Laws and regulations: in sustainability initiatives, laws and regulations can play a role. This section of the interview briefly explores this theme.

In what way do laws and regulations play a role in sustainable waste management initiatives offered by (company name)?

What are the biggest bottlenecks when implementing sustainable waste management initiatives?

- Summarising interview
 - Do you have anything to add/ask yourself?
 - Are there any topics that were not sufficiently covered?
- Feedback of results
- Informed consent
- Thank you