The wasted Disposables in Dutch Hospital's health care pathways.

Thesis for the master of Transport Infrastructure and Logistics of the TU Delft

Figure 1 Freight logistics in health care (LOGISTIEK, 2012)

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Preface

This report on the research of the wasting of disposables in Dutch hospital's health care pathways, originated from the idea of the lecturer Ir. M.W. Ludema from the TU Delft, to find supply chain opportunities in the Dutch health care system. Being a technical educated master student, in the direction of transport, infrastructure and logistics, directed the focus of this research on the goods logistics in the Dutch health care system. From a preliminary research, to map problems within the goods logistics supply chain within the Dutch health care system, a hypotheses was derived that disposables are wasted within Dutch hospitals. This hypotheses was constructed from the lack of information that could be provided by the logistic managers of multiple Dutch hospitals. This lack of information provides room for potential problems to exist.

This research is conducted on the behalf of the Centre of Practice (COP) for health care logistics, which is part of the KennisDC Logistiek of the province of South Holland. This is a research organisation affiliated to the Rotterdamse Hogeschool. The COP wants to do further research in the health care logistics and this report will be a starting point for this research.

Acknowledgement

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Abstract

The Dutch health care system is a large drain on the Dutch national budget. With the Dutch hospitals costing 20 billion euros yearly. Six billion euros, of the total 20 billion euros are spend on goods and materials. If a part of these goods are wasted within the health care system, the costs of this system could be reduced by reducing this waste. This report has researched the possible waste reduction possible in health care pathways by researching three health care pathways in Dutch hospitals. This report answers the research question: *How can the possible wasted disposables be reduced in health care pathways in Dutch hospitals*. This question is answered with the creation of a framework based on multiple case studies created from research done in the three health care pathways, Percutaneous Coronary Intervention, Cataract and Hip Fractures. These health care pathways are visualised using IDEF0 diagrams, and the disposable flows are shown in matching tables. To provide constructive solutions to possible wasted disposables within health care pathways in Dutch hospital in general, a framework is constructed. This framework generalizes health care pathways to four basic steps, diagnostics, pre-operation, operation and post operation. The main solutions to reduce the chance of wasted disposables within health care pathways, is to improve the amount of standardisation of disposables used and needed, and improve the communication and collaboration between parties within the health care pathways. These solutions are based on the case studies and the literature research on the Dutch health care system in general, Dutch hospitals and the goods logistics within the Dutch health care system. This also provides an answer to the research question, on how to reduce disposables being wasted in health care pathways in Dutch hospitals. This thesis research is conducted on three care pathways are researched in multiple hospitals, but not all Dutch hospitals. Different results could be reached when researching other health care pathways or different hospitals, but the framework provided in this report could be valid for these different situations. Both the validity of this research and the constructed framework has to be researched in subsequent research studies. These subsequent research studies have to verify if the conclusions derived in this research is valid for other health care pathways and if the framework is applicable and if it has achieved its objective.

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1 Introduction

The Dutch health care system is a large drain on the Dutch national budget and counts for 15.6 percent of the GDP in 2013 (CBS, 2014) (NEVI, 2011). These expenses will increase in the future, because of the increasing percentage of elderly and the new medical procedures probably becoming more expensive and specialised. To keep these expenses in check, the Dutch health care system is going through a lot of new cutbacks and changes aimed at qualitative improvements to maintain the current quality level with a smaller budget.

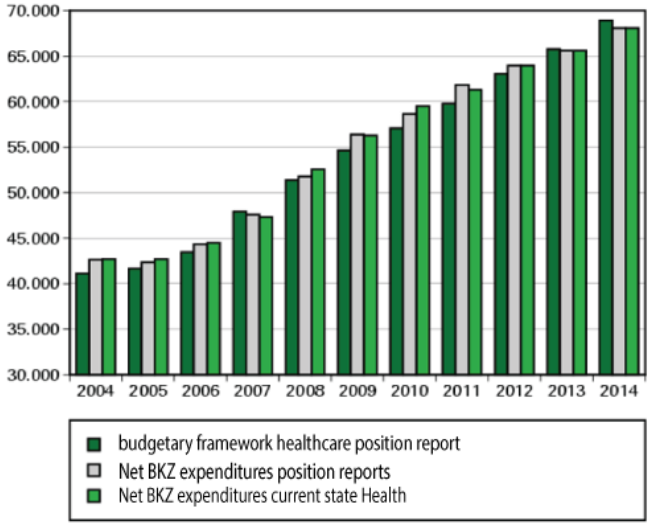

Figure 2 health care expenses 2014 (Rijksoverheid, 2014)

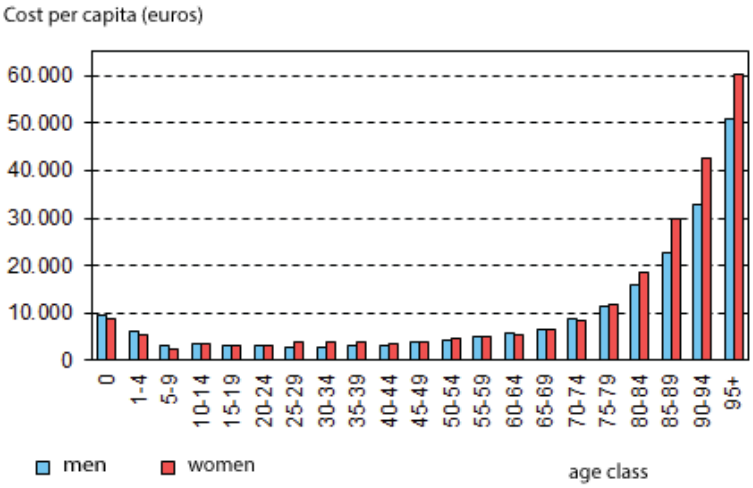

Figure 3 Health care expenses per age class (Rijksinstituut voor Volksgezondheid en Milieu, 2011)

A part of the expenses made within the Dutch health care system has to be contributed to the 155 Dutch hospitals (Dutch Hospital Data, 2013). These hospitals had a total cost of 20.4 billion euros in 2012. Around six billion euros of these total costs were for the acquisition of goods and materials. These costs are increasing yearly with an average growth of 5.9%.

Based on interviews with logistics managers of different Dutch hospitals, it is not clear how many disposables are wasted within these hospitals. This inabilety to difine the amount of wasted goods in Dutch hospitals, creates the research purpose of this paper. Because if disposables are wasted, while this ccould have been prevented, it would mean that the costs for disposables in hospitals is needlessly high. This research paper focuses on the construction of a framework to reduce the possibility for disposables to be wasted. Therefore, the identification of the wasted disposables in Dutch hospitals is the first goal of this research. Secondly, a framework will be constructed that provides solutions that will reduce the possible wasted disposables within hospitals.

After this introductory chapter, the report starts with an overview of the research methodologies which will provide the research guidelines and questions for this research paper. The next chapter provides the background information on the health care system and goods supply chain in the health care system. After this a basic framework is constructed, which provide a structure for both the case study research and the final framework. The fifth chapter of this report will show the results from the case studies conducted in the different health care pathways. The sixth chapter is a proposed framework for a standard health care

pathways including waste reduction solutions for disposables. This framework is based on the information collected in the previous chapters. This framework and the previous chapters will provide the backbone for the conclusions and recommendations which will be stated in the seventh chapter, with a comments sections ending this report in chapter eight. After these chapters some last pages will be filled with a bibliography and appendixes.

Figure 4 Examples of medical disposables (Ebony, 2014)

2 Methodology

2.1 Introduction

Research projects all need methods to provide a structured final product. This chapter will provide an overview of the methods used in this report. The chapter starts with multiple research questions based on the problem statement found in the introductory chapter. After this paragraph on the research questions, the research scope will provides a frame for this report. After which a more extensive description of the different researched health care pathways is provides. These paragraphs provides a clear frame for the research methods and requirements, finishing this chapter.

2.2 Research questions and analyses objectives

To solve the stated problems, answers are needed which are created by research questions. These research questions are divided into a single main question and multiple secondary questions. These questions are the bases for the different research objectives.

2.2.1 Main research question

As previously stated, there is limited knowledge on the wasted disposables in Dutch hospitals. The assumption that disposables are wasted and that this waste can be reduced is researched in this report. The research will be limited to health care pathways within hospitals because of the time constrain of this research. The central research question of this research is:

- How can the possible wasted disposables be reduced in health care pathways in Dutch hospitals?

2.2.2 Main research objective

This main question provides the bases for the main research objective of this report. This main objective is:

- To create a clear image of solutions to reduce the wasting of disposables in health care pathways in Dutch hospitals.

2.2.3 Secondary questions and objectives

The main question can be divided into multiple secondary questions. This is similar for the secondary research objectives, which are derived from the main research objective.

2.2.3.1 Secondary research questions

1. What is the current state of the goods logistics supply chain in the Dutch hospitals?
2. What actors are most relevant to the stated problem?
3. Which disposables are wasted in the example health care pathways, Percutaneous Coronary Intervention (PCI), cataract and hip fractures?
4. What are the reasons for disposables being wasted in Dutch health care pathways?

2.2.3.2 Secondary research objectives

A. To provide case study research that replicates real life, using the health care pathways as examples, to show both the good and bad practices in the Dutch health care goods logistics supply chain.

B. To provide a framework on health care pathways with solutions included that reduce the possible wasted disposables.

2.3 Research scope

This chapter will provide the research scope of this report. This scope provides a framework and rules on which the research is conducted. This scope is divided into six parts:

1. The selected section of the supply chain.
2. The selected health care pathways.
3. The selected health care facilities.
4. The definition of disposables.
5. The definition of waste.
6. Other assumptions.

These six parts all provide a separate framework for the research and will be separately explained in the next sub-paragraphs.

2.3.1 The selected section of the supply chain

Because of time constrains not the entirety of the health care system can be researched. The parts of the health care system that will be researched are the cure facilities in the Netherlands, specifically the hospital facilities and organisations. In figure 5, the part of the health care system that will be researched in this report is visualised by the area marked in green with the facilities marked in yellow. The focus of this research will be on the larger facilities and the different departments and specialists included in these facilities.

The level of detail of this report is up to the facility level. This means that the end of the goods logistics supply chain, in this report, is the delivery of disposables to the different departments of a given facility. These departments are the end users of the disposables and the clients in the goods logistics supply chain. The part of the goods logistics supply chain that is researched starts in the central warehouses or cross dock centre and ends at the different departments of the cure facilities. This excludes the different suppliers and wholesalers of the different disposables. This also excludes the patient as party within this supply chain.

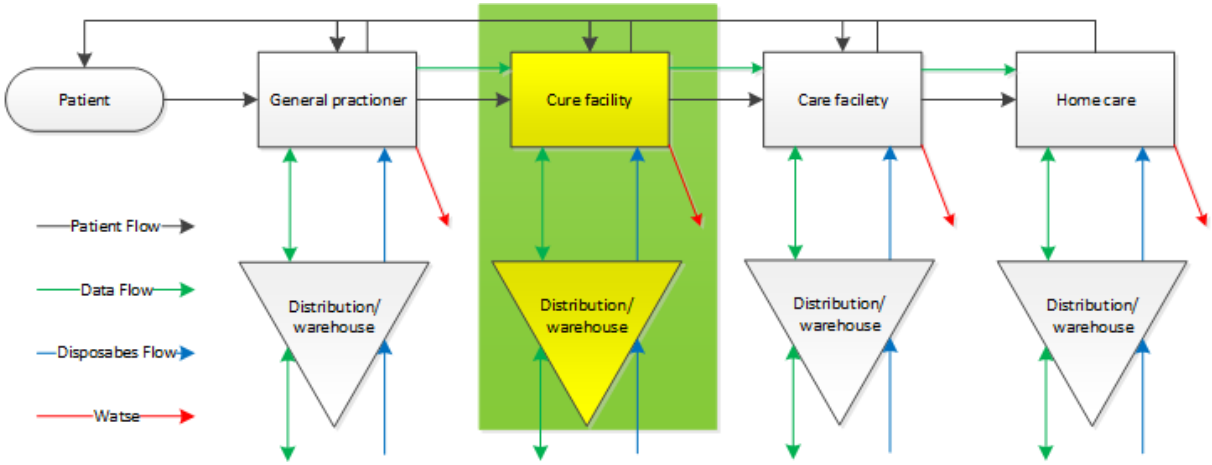

Figure 5 The supply chain research scope

2.3.2 The selected health care pathways

Health care pathways, also called clinical pathways (European Pathway Association, 2015), are predetermined routes throughout the health care system resulting from a specific health care problem and for a specific group of patients. These pathways are established for diseases that have clear health care solutions. Health care pathways can also be described by a diagnosis treatment combination (DBC). DBC's are codes used within the health care system to describe all types of medical procedures.

Three different healthcare pathways are researched. These three health care pathways are chosen by five different factors. Of these five factors, the first three factors are required for every health care pathway to be researched. While a minimum of only one of the last two factors is compulsory. These factors and the specific health care pathways were determent on the basis of two interviews with health care pathway specialists in two Dutch hospitals.

1. A relatively large influx of patients yearly.
2. A relatively short throughput time
3. Multiple departments have to be moved through, preferably a surgery
4. Part of the procedure can be scheduled
5. After the procedure in the cure facility aftercare is scheduled in a different facility

These factors are based on the nature of the research and the research problem. A large influx of patients is needed to assume that any small cost reduction still has a large total effect. A short throughput time is necessary because of the time frame of this research, which originally was 6 months. To fully research these health care pathways and possibly follow a patient throughout these pathways, these patients have to move through these pathways within days. The third factor is derived from the notion that most faults originate in interfaces. If a patient moves throughout multiple departments, the possibility for waste becomes greater. Especially for a surgery department, which uses in average more specific and expensive disposables. The last two factors are derived from the request to find supply chain opportunities. None of these factors determine if these health care pathways are representable for all health care pathways. None of the health care pathways chosen are selected to be representable for all health care pathways and only used as examples.

Three health care pathways that satisfy these stated requirements are:

- Chest pains with the treatment Percutaneous Coronary Intervention (PCI)
- Cataract
- Hip fractures

These health care pathways will be used as examples and guidelines for the design of the health care pathway framework. In appendix C the DBC codes for the researched health care pathways are stated.

2.3.3 The selected health care facilities

This research focusses on cure facilities (hospitals) in the Netherlands. The specific hospital that will be used in this research are chosen by two different requirements. The facilities has to be within a reasonable travel distance of Breda, the hometown of the researcher. And the hospital has to be willing to provide the resources needed for this research. The first

hospitals that were reached out to participate in this research where previous contacts provided by the different research coaches. Other parties where chosen by the stated location limitations. The organisations where this case study researched was conducted are: Erasmus MC, Maasstad Hospital and Rivas.

2.3.4 The definition of disposables

This report defines all goods that have a onetime use for one patient as disposables. These goods are the focus of this research. Examples of these goods are medical stents, catheters, medical gloves, eye lenses and hip prosthesis.

2.3.5 The definition of waste

The different actions that take place in a health care pathway can all produce waste. This report defines three different types actions (Rich, 1997).

1. Non-value adding actions
2. Necessary but non-value adding actions
3. Value adding actions

All non-value adding actions can be seen as waste, but some of these actions are necessary and can only be reduced by drastically changing the processes involved in the action. This report will focus on non-value adding actions that are not necessary. The waste of the non-value adding actions that are not necessary can be defined using the Lean method, which divides waste in seven types (Rich, 1997):

1. Overproduction
2. Waiting
3. Transport
4. Inappropriate processing
5. Unnecessary inventory
6. Unnecessary motion
7. Defects

This research focuses on one of these types of waste, the unnecessary inventory. This means that the focus of this research is on the wasted disposables due to expiring or improper use. The chosen types of waste are determined from the type of research conducted and information available. This research focuses on types of waste that are avoidable, some waste will always exists in any operation where people are involved, especially in the health care where people are both the operator and the platform where is operated on. This unavoidable waste will not be part of this research.

2.3.6 Other assumptions

The assumptions that are made in this research will provide a guideline for both the research and project deliverables. The main assumption, is that the amount of supply given and demand created in the health care system will not be part of this research. Both 'demand and supply' are outside the scope of this report, because a logistic engineer has limited knowledge and persuasion about the factors influencing them. The second assumption is based on the same limitation of expertise as the previous assumption: Both the drugs and medical equipment are not in the scope of the research, because the importance of these

resources cannot be defined by a logistic engineer. If this research would imply that changes have to be made in the use of the drugs and medical equipment, these recommendations would probably not be adopted in the field.

2.4 Research methods

The research in this report will be divided into two phases, an analyse phase and a design phase. These two phases use different methods to answer the research questions and design objectives. The analyses phase uses theoretical literature research to provide an understanding of the current situation of the goods logistics in the Dutch health care system and Dutch hospitals. This knowledge will be extended by interviews with the different actors involved in de goods logistics and the Dutch health care system. These methods are also used to answer the question on the influence and power of the actors involved in this supply chain.

To answer the last three research questions, an extended field research will be conducted. This field research will consist of:

- Multiple interviews with actors of these relevant health care pathways on the amount of wasted disposables sustained in these health care pathways.
- Field research, consisting of following multiple procedures in the different health care pathways.

A couple of case studies are constructed based on these interviews and field research. These case studies will aim to replicate real life, using the health care pathways as examples, to show both the good and bad practices in the Dutch health care goods logistics supply chain. This case study research, combined with the data collected from the literature study will create a clear image on the wasted disposables and possible solutions. These case studies will be constructed using the IDEF0 method. This IDEF0 method is a tool to create value stream map.

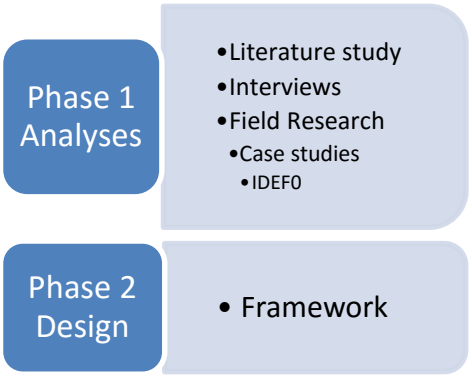

Figure 6 Research methodologies summary per report phase

The second phase, the design phase, will answer the main research question. Within this phase, a framework is constructed that provides a tool to reduce the possible wasted disposables within a health care pathway. This framework is constructed based on the data acquired and researched in the first phase.

Apart from the research methods used within this report there is also a methodology used to find both definitions for waste and solutions to reduce waste. The method used for this is the Lean Six Sigma method. This and the other methods used in this report are described in the following paragraphs.

2.4.1 Case study research

Case study is a research methodology used to research different real life situations to provide inside views in those situation. These inside views are created by replicating the real life situation in a visual model. (Kathleen M. Eisenhardt, 2007) Case study research can be

conducted on one or multiple different real life scenarios. When using case study research for a single scenario, this research provides knowledge on that specific situation. If multiple scenarios are researched simultaneously, a generalized image can be created. This research report will use multiple cases to create a general image of the state of wasted disposables in the health care pathways in Dutch hospitals.

2.4.2 IDEF0

IDEF0 is a value stream mapping tool originally developed by the US Air Force Integrated Computer Aided Manufacturing (ICam) (Joseph Sarkis, 1995) (Hanrahan, 1995). IDEF stands as acronym for ICAM Definition. The IDEF0 method is a functional model that consists in basic of a box, that represents a function or activity, and input arrows that represent the input, output, control and mechanism that affect the function or activity, see figure 10. IDEF0 models can consist of multiple levels with every level being a low level diagram of the parent diagram, as seen in figure 11. IDEF0 is an effective model to show a baseline of a process, to improve the understanding of this process and to eliminate redundant function within the process.

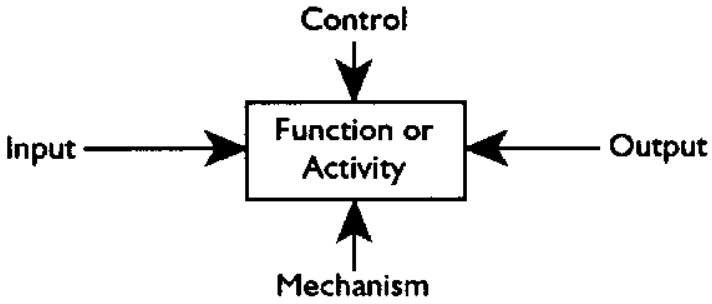

Figure 7 Basic IDEF0

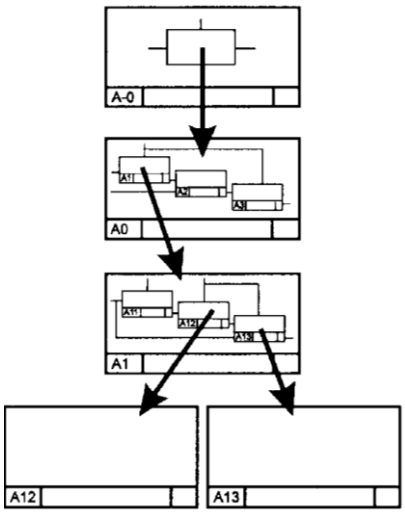

Figure 8 IDEF0 with different levels of diagrams

2.4.3 The Lean six sigma method in the Dutch health care

The Lean Six Sigma method is based on the Lean and the Six Sigma methods. The lean method focuses on waste reduction to improve value in a system. This method identifies seven types of wastes, as previous descripted in the scope of this research. Six sigma is a method to reduce variation in a process, to reduce costs. The two combined not only provide a methodology to reduce waste and non-value adding processes, but also a framework to improve to overall organisation culture (Sumers, 2010).

The Lean Six Sigma methodology is already used in the Dutch hospitals, with success. Examples of this are the UMCG (Lean Six Sigma blijkt het ideale middel om betere zorg te krijgen tegen lagere kosten, 2008) and the top clinical hospital Medisch Spectrum Twente (R.J.M.M. Does, 2011). Both these examples show the cost reduction that can be achieved when using the Lean Six Sigma method. In the research in the top clinical hospital Medisch Spectrum Twente it became clear that a reduction of 20% of IV pumps could be realised when using the Lean Six Sigma method.

2.5 Requirements

To provide an answer to the stated research and design questions, research requirements have to be formulated. These requirements need to structure the research to answer these

questions clearly and provide boundaries to restrict the design. The requirements are divided into three parts: analyses, case study and framework requirements .

2.5.1 Analyses requirements

The analyses are required to answer the first part of the secondary research questions. This means the background information has to be presented to construct a design to provide a clear image of the wasted disposables in health care pathways in the Dutch hospitals.

2.5.2 Case study requirements

The case study is required to fulfil the targets of the analyse requirements. This means that the case studies have to provide a clear image of the state of wasted disposables in the health care pathways. This main requirement can be fulfilled by secondary requirements:

- The health care pathway has to be clearly formulated, even if it is a summarized version of the health care pathway.
- All disposables that are used for the patient in the health care pathway have to be defined per department.
- All costs for the used disposables have to be clearly visible.
- All wasted disposables and the costs for these losses have to be stated.

2.5.3 Framework requirements

The constructed framework is required to provide solutions to possible wasted disposables in health care pathways in Dutch hospitals. This framework is constructed to answer the main research question. This has to be based on information researched in the analyse phase. This framework has to clearly state the solutions and the arguments that are the bases for these solutions.

3 Health care system analyses

3.1 Introduction

The Dutch health care system consists of multiple parties, with hospitals as focus of this report. The health care pathways researched are situated in hospitals. This chapter will provide some background information on the health care system, hospitals and the health care pathways needed for this research. This chapter starts with an analyses on the Dutch health care system. After this analyses on the different types of hospitals, logistic supply chain of disposables in these hospital and the health care system, the connection of this goods supply chain to the information flow in Dutch hospitals is researched. This chapter ends with the actor analyses.

3.2 Health care system

The health care system, as defined in this report, consists of all parties involved that have a direct connection with the patient and the health care provided. This starts usually with the general practitioner. This party will provide the first health care or redirect to a cure or care facility. The patient will move throughout the health care system to ideally be cured and go back home. This report focusses on the health care system from the moment the patient enters the cure or care facility until the patient is not provided any cure or care anymore.

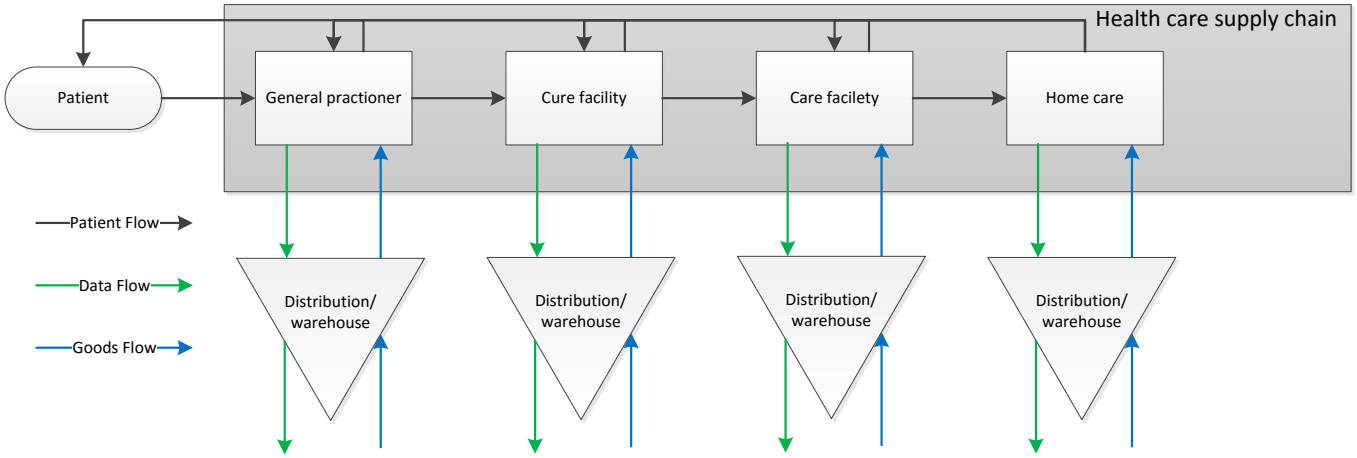

Figure 9 Health care system overview

3.2.1 Dutch Hospitals

As previously stated, there are quite a few hospitals in the Netherlands, 155. Not all these hospitals have the same size and function. In this report different types of hospitals are used for the case studies. This research recognizes four types of hospitals (Oosterwaal, 2011). Regional, specialized, academic hospitals and top clinical. Regional hospitals are the basic type of hospitals in the Netherlands, while the other three types are variations on this basic type. Specialized hospitals are specialized versions of the basic hospital type which focus only on one type of disease or one type of treatment. Academic hospitals are hospitals where students can be trained to be physicians and top clinical hospitals are hospitals where physicians can train and learn skills.

3.3 Goods Supply chain within the Health Care system

The supply chain of goods in the health care system is divided into systems that are interconnected. The first is the health care system through which the patient moves to receive health care. The second is that of the goods moving from supplier to costumer. These two systems are deeply connected because the demand for the goods transport is created by the health care provided to the patients in the health care system.

3.3.1 The goods supply chain

The goods supply chain in the Dutch health care system consists of the chain between supplier and customer, with the customer being the health care facilities. The connection between these two parties is the demand forwarded by the purchasing department of the health care facilities and the freight moving from the supplier to the client and all parties in between. The number of parties involved in this supply chain is variable between facilities. Some facilities have their own warehouse and directly purchase from the different suppliers or wholesalers. Other facilities have external parties maintain their warehouses or they outsource the whole external freight logistics.

In figure 10 the supply chain of the goods logistics in the health care system is visualised.

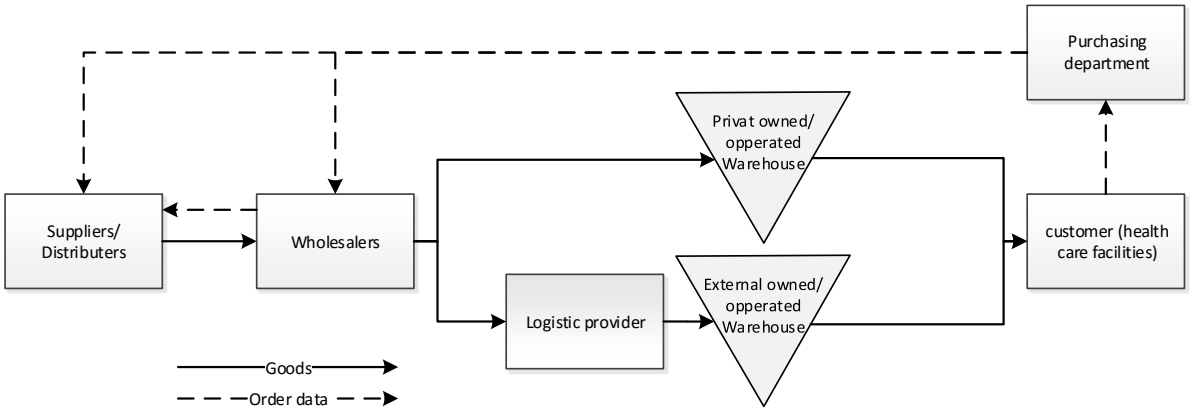

Figure 10 Goods logistics supply chain

3.3.2 Connection of the health care system and the goods supply chain

There is a connection between the goods supply chain and the health care system. This connection, while being there, it is not taken into account in the planning of the health care system in the real live. In this report the focus of the research is in this connection and the improvements it can create for the goods logistics. This supply chain is visualized in figure 11. This visualization takes into account that there is very limited communication between

the different parties involved within the health care system when the goods logistics are concerned. And the amount of collaboration between the different parties is also limited.

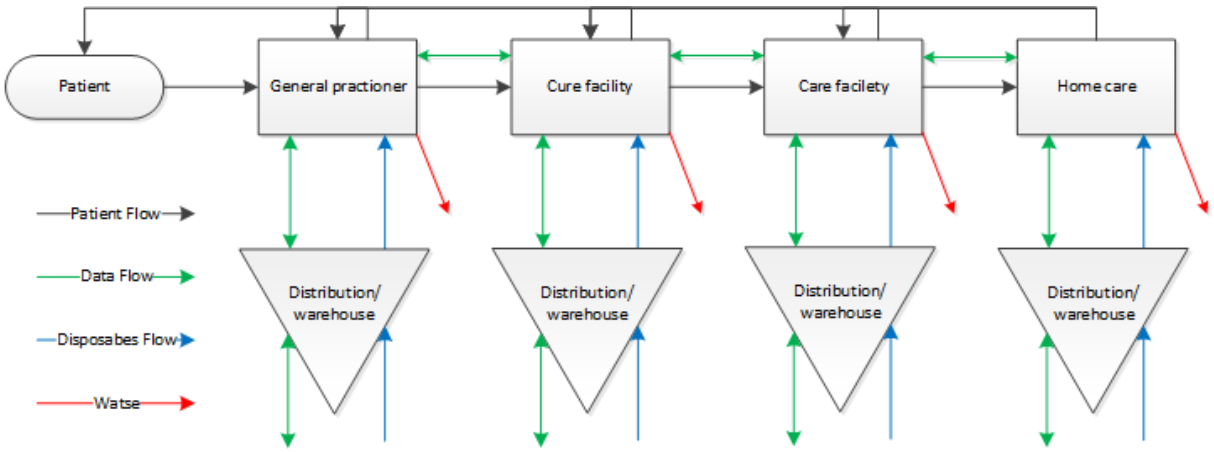

Figure 11 Combination of the health care system and the goods supply chain

3.3.3 Goods supply chain within the Dutch hospitals

The previous paragraph provides an overview of the logistics in the health care system. In figure 12 the internal supply chain within hospitals is shown, this is the "last 100 meters" of the goods supply chain. In this figure it is shown that the goods are delivered to the logistics department in the health care facility from which the goods are distributed to the different departments, with or without first storing the goods in the internal storage. The different departments make orders using the organization's ordering system. The goods delivered to the different departments are all on order bases, this reduces the logistics department to just the receiver of external goods and transporter of internal goods. The communication between the different departments and the logistics department is very limited, but is improving in the last couple of years.

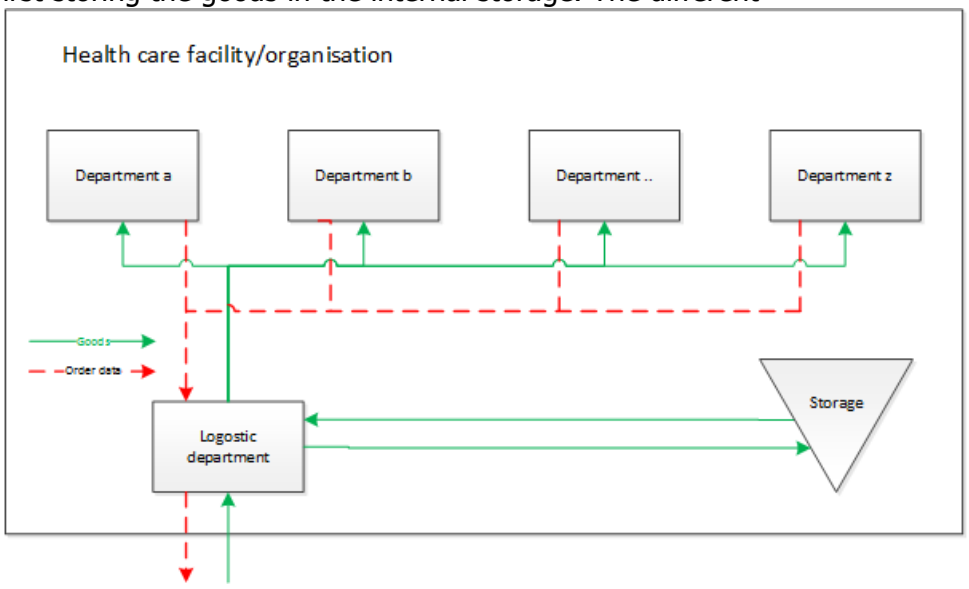

Figure 12 goods logistics in health care facility

The goods flow within the health care system is order based. These orders originate in three different ways:

1. Orders from daily checks of stored goods
2. Single specific/non-standard orders
3. Orders based on planned procedures

The first method of orders originate from daily checking of the hospital storages for available goods. The central warehouses are mostly checked using computer systems that automatically control the amount of stored goods and makes orders accordingly. The local storages in the different departments are mostly checked daily by hand, and if the amount of stored goods run low while being on the list to be automatically ordered, an order for these goods is placed. Goods that are not on this automatically order list, have to be ordered separately using single orders, which is the second method of ordering.

The list of automatically ordered goods is determined by, the amount of these goods used daily, the costs of the goods, the amount of storage needed or the importance of the good being available at all times. This list of automatically ordered goods is different per departments and is regularly checked by staff of the department. These checks focus on which goods should be on or of this list, to make sure that the level of health care provide is high without unnecessary costs.

The third method for orders is based on planned procedures. Most procedures are planned in advance, especially in health care pathways. Because of this forward notice of which procedure is done and what is needed for this procedure, goods can be delivered to the operation room, just in time and specifically ordered to match the procedure requirements. This method of goods delivery and planning is similar to the Lean Six Sigma method, as described in chapter 2.4.3.

Most orders proceed through the sales department, with only a small percentage of ordered goods going outside the hospitals ordering system. The orders going through the sales department are ordered at the suppliers, if not available within the central storage. These orders are translated into goods transported from the suppliers to the central warehouse. At the central warehouse, carts are prepared for the different departments. These carts are offloaded in the local storage, in storages in the patient's rooms or used as local storage, mostly in operation rooms. The goods stored in the departments local storage is mostly used in a first in first out principal (FIFO). The goods stored in the patients rooms are stored in small quantities and only goods that have a high throughput are stored here. This reduces the chance of these goods to pass their best before date (BBD) and reduces the waste of disposables.

Hospitals have in average more than a hundred different suppliers of goods and disposables. These suppliers are connected to the hospital in two ways. The first connection is that of shared information between the hospital and the supplier, with orders placed by the hospital as main information flow. The second connection is that of the goods flow. These goods flow from the supplier to the hospital to complete the orders from the hospital.

This next figure shows a broad overview of both the flow of information needed for the goods flow and the flow of goods itself.

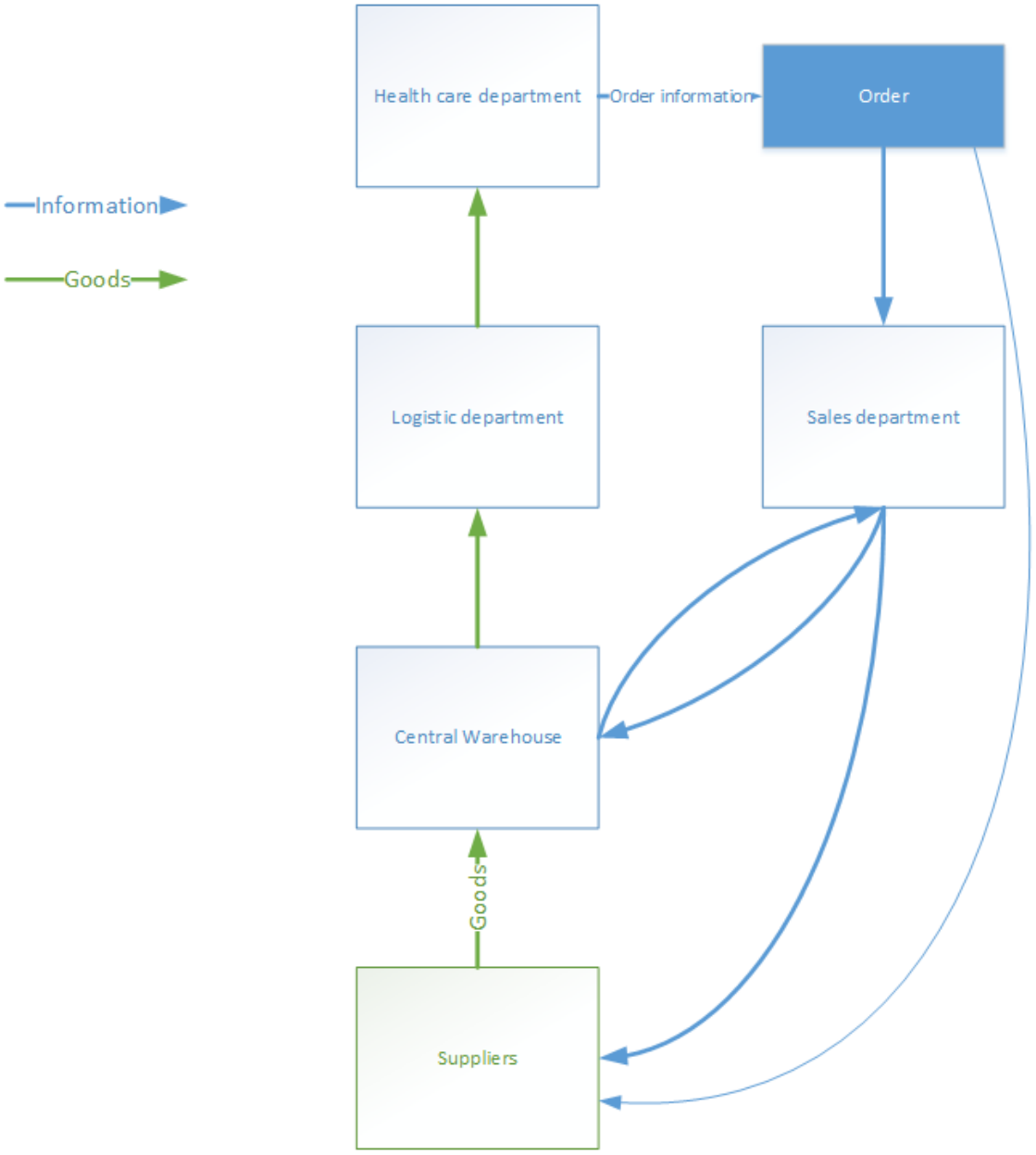

Figure 13 Goods and information flow

3.4 Actors and stakeholders of the Health care system

Multiple different parties are involved in the health care system and the goods logistics. To reduce the amount of wasted disposables within health care pathways, some of those parties have to be involved to implement the solutions stated in the framework. These parties can be divided into stakeholders, parties that have an interest, and actors, parties that act. These different stakeholders and actors will be stated in this chapter and their ability to act, their power, and their interest to act will be researched.

3.4.1 Inventory of actors and stakeholders

The health care system has many actors and stakeholders. This paragraph will provide an overview of the actors and stakeholders involved in this research. This report focuses on the last 100 meters of the goods logistics supply chain in the cure facilities and the actors and stakeholders involved in this supply chain. All other actors of the health care system and goods logistics supply chain will be seen as stakeholders. The parties that are involved in that specific part of the supply chain are (Rijksinstituut voor gezondheid en milieu, 2014):

Table 1 Actors and stakeholders in the Dutch health care system

Actors	Stakeholders
Hospitals	**Hospitals**
Physicians	Patients
Nurses	Hospital board of directors
Logistic manager	Care Facilities
Health care department manager	Home care organisations
Department sales	General practitioner
	Pharmacies
	Supplier/distributer
	Wholesaler
	Transporters
	Government parties
	Health care insurance companies
	Logistics provider

Actors

3.4.1.1 Physician and nurses

Both physicians and nurses are the physical contacts between the patient and the health care facility. They provide the health care that the patient demands. The difference between the two parties is that the physician is the main provider of cure and the nurses are the provider of care. The physician is the person who is ultimately responsible for the patient. Physicians have had the privilege to have a lot of influence in the health care facilities, this influence has decreased in the last years, but their power is still existing.

3.4.1.2 Logistic manager

The logistic manager is the controller of the logistics department of the health care facility. This department is responsible for the internal transport of goods within the health care facility. In the last year, the importance of this supportive department has increased in the eye of the health care facilities, but the influence of this department has not increased in the same way.

3.4.1.3 Health care department manager

The health care department manager is the controller of the health care department. The manager is responsible for the well operating of the department, both medically and financially.

3.4.1.4 Sales department

This department is responsible for the purchasing of any goods needed in the health care facility.

Stakeholders

3.4.1.5 Health care, home care and cure facilities/organisations

These actors consists of all health care and cure parties within the Dutch health care system. These parties are the end users of the freight transported through the freight logistics supply chain. These parties create the demand for the goods and have therefore the most power in the supply chain. The parties involved in the health care and cure supply chain are (Rijksinstituut voor gezondheid en milieu, 2014):

- Cure organisations
  - Hospitals
- Care organisations
  - Healthcare centres
  - Physical Therapy Practices
  - Rehabilitation institutions
  - Mental health / ambulatory care
  - Child and adolescent psychiatry / child welfare
  - Nursing Homes
  - Handicapped care
  - Care homes
- Home care
- Pharmacies
- General practitioner

3.4.1.6 Logistics providers

The logistics providers are organisations which provide the external transport and storage of the goods needed by a health care facility. These organisations are paid, by the health care facility, to solve all external logistics needs. These logistical needs can consist of only managing the external warehouse and transport from and to this warehouse, but also the purchasing of the goods and managing the suppliers for the health care organisation. Companies that provide this type of service are:

- Hospital Logistics
- King
- Zorg Service XL

3.4.1.7 Transportation companies

These companies provide the needed transportation between the different parties within the supply chain. This can be done by a party that is owned by the health care organisation, part of another supply chain actor or an external party. The power of the different transportation companies is limited, because of the multitude of different parties available to provide the transportation need of the health care supply chain.

3.4.1.8 Suppliers, distributers and wholesalers

The suppliers, distributers, and wholesalers are the organisations that produce or distribute the different goods used in the Dutch health care system. This group of organisations consist of a multitude of companies, which reduces the amount of power that the individual company has within the Dutch health care system.

3.4.1.9 Governmental parties

Governmental parties make the laws and legislation that govern the health care system and goods logistics supply chain. These organisations decide on the minimal level of service that has to be provided in any health care organisation. These governmental parties have a lot of power, but if all other parties obey to the stated rules, they have a low interest.

3.4.1.10 Patients

The patients are the parties that require the health care given in the health care system and are the reason for the health care system to exist. Any singular patient has low power, but a large interest in a perfectly functioning health care system. If all patients unite, they have a lot of power.

3.4.1.11 Health care insurance companies

The insurance companies provide the finances for all interventions done in the different health care facilities. These insurance companies try to keep their expenses as low as possible. They can only do this by reducing the cost for health care or reduce the number of patients. By law, these insurance companies are not allowed to refuse any patient. This means that the only reduction in expenses can be achieved by reducing the costs in the health care system. These companies have a lot of power and interest in the health care system and the costs involved in this system.

3.4.2 Actor mapping

The different actors involved in this problem are all connected with each other. These connections can exists in the form of information sharing, setting of rules and regulations, providing finances or the transportation of goods. In figure 14, these connections and the location of the actors in the system are visualized. In this image only the main connection is shown and in which direction this connection goes. This actor map will show the actors and stakeholders on both health care system and hospital department level.

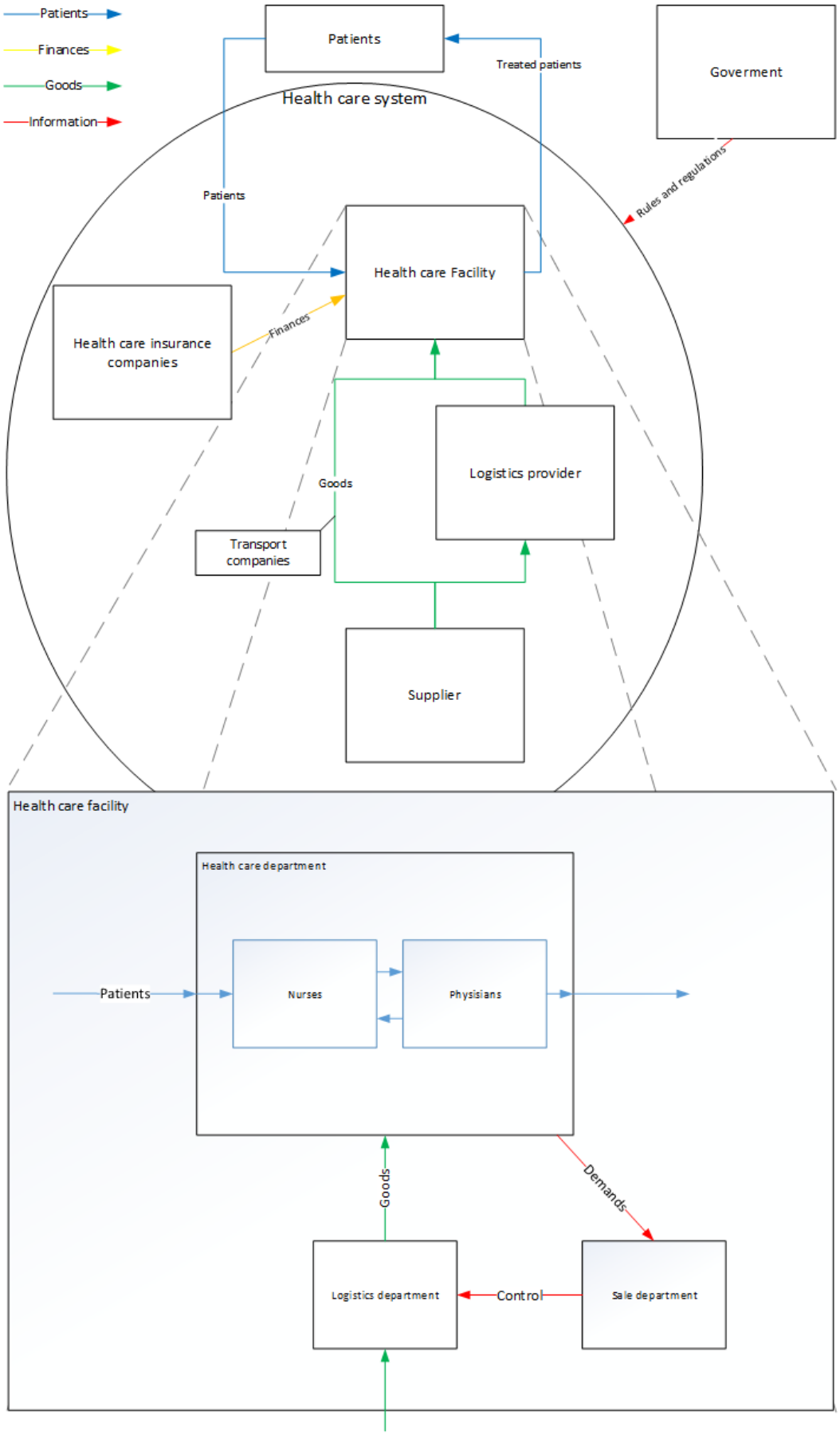

Figure 14 Actor mapping in the Dutch health care system

3.4.3 Power interest matrix

The framework that is constructed in the sixth chapter of this report will provide solutions for the reduction of wasted disposables in Dutch health care pathways. To implement solutions in a multi actor environment, the power and interest of all these actors have to researched. With this data, the important actors for the implementation of the different solutions can be found and handled appropriately. The power and interest of the different actors directly involved in the health care pathways and the possible solutions are visualised in a power interest matrix. This matrix is constructed based on information researched in the literature study and the interview.

The parties that will be part of this power interest matrix are:

1. Physicians
2. Nurses
3. Logistic manager
4. Health care department manager
5. Department sale
6. Suppliers, distributers and wholesalers
7. Patients

These actors have the direct connection with the disposables in the Dutch health care pathways and are the first group of actors that have to implement solutions.

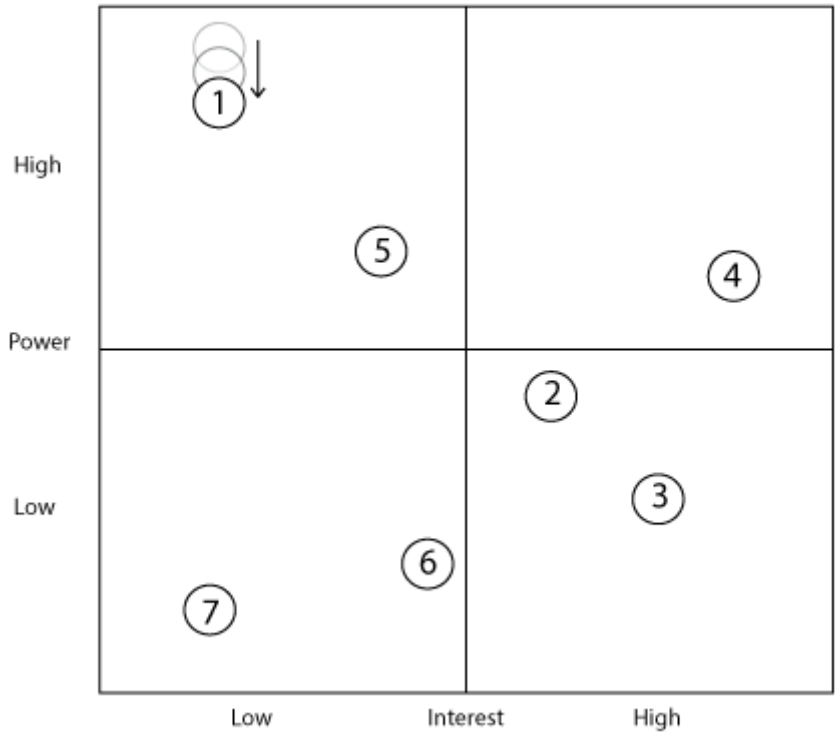

Figure 15 Power interest matrix

As shown in the power interest matrix the physicians and the sale department are the actors that could be adversaries to change. The physicians have had historically a lot of power in hospitals, but this has been decreasing in the last year. Physicians are relatively stubborn

and adverse to change. This is partly because during the study to become a physician, the trainees are learned to do procedures a certain way and they are not convinced to change this way easily. This actor will need to be convinced to implement the proposed changes that this report will suggest.

The sales department is a lot easier to convince to adapt changes. This can be done by involving them early in the process and providing clear proposed profits. The sales department is probably easily convinced to reduce costs, a by-product of reducing waste. If this is done correctly, this department could also become a collaborator for the implementation of the proposed solutions.

The other parties are all less likely to become important adversities. This is because these parties have a high interest in reducing the wasted disposables or have limited power within the system.

4 Basic framework

4.1 Introduction

Health care pathways exists for many different health care procedures. As described in the previous chapter, different practices for the goods logistics within these health care pathways exists. This chapter will provide a standardized overview of a general health care pathway. This overview will be used to construct both the standard IDEF0 that will be used in the case studies and the basis for the framework.. This overview is based on the data researched in the previous chapter.

4.2 Health care pathway structure

Health care pathways exist in many different forms for just as many different procedures. But in average all health care pathways consists of 4 different steps, the diagnostics, the pre-operation , the operation and the post operation steps.

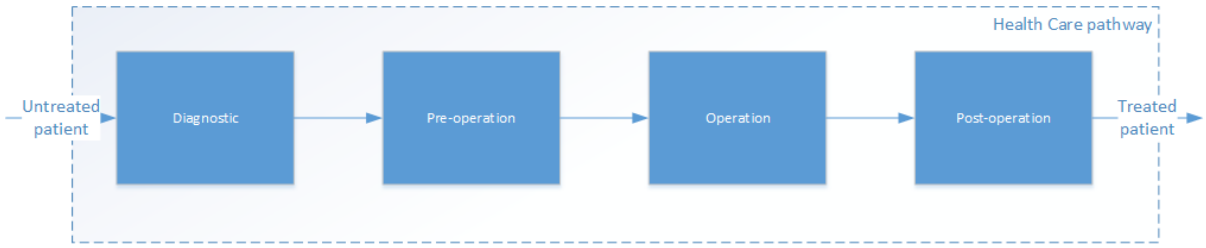

Figure 16 Health care pathway structure

Every pathway starts with a diagnostic step where the type of operation is determined and with this the health care pathway. After the diagnoses the patient will move to the pre-operation. At the pre-operation the patient is prepared for the medical procedure at the operation. After the pre-operation the patient will move to the operation and after the procedure is finished the patient will move to the post-operation. In the post-operation, the patient can recover from the medical procedure and be prepared for discharge and the move to after care or back home. Not all health care pathways will conform to this structure, but the framework derived from this structure can be used to improve waste reduction of disposables in most health care pathways.

4.2.1 Planned or non-planned procedures

Planned procedures are non-acute procedures were the patient can wait, and even go home, between the diagnostics and the pre-operation step of the health care pathway. Non-planned procedures are acute procedures were the patient cannot wait. The waiting time between diagnostics and pre-operation determines if the procedure can be a planned or a non-planned procedure. In this report, the time that a patient has to wait for entering the health care pathway for an acute procedure is set to less than a day. If this time is longer than a day then the procedure is plannable and non-acute. This

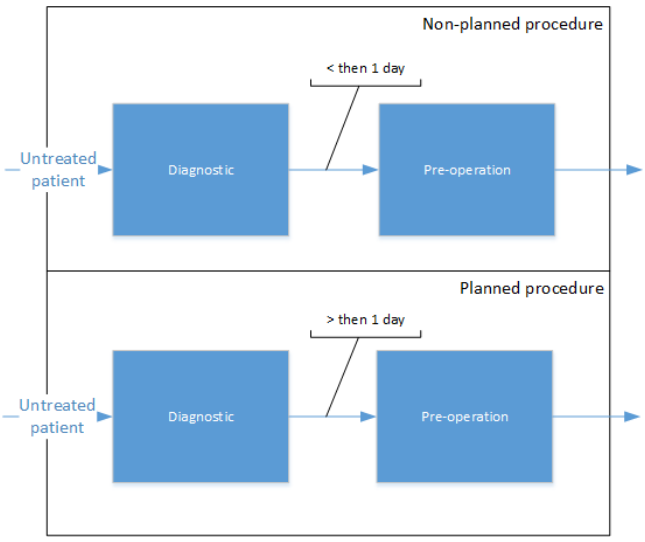

Figure 17 Planned and non-planned procedures

timeframe is used in this report to give a more structured difference between planned and non-planned procedures, and is not based on any research. The difference between planned and non-planned procedures has to be specified, because planned procedures are often easier to optimize and preferred for logistic purposes. This difference will be taken into account by the construction of this framework.

4.3 IDEF0 structure

The basic structure constructed in this chapter will translate in the basic IDEF0 diagram that will be used in the different health pathway case studies. This basic IDEF0 diagram will provide a clear structure for the different health care pathways and the framework that will be constructed based on these case studies. The IDEF0 diagrams used in the case studies will describe the different procedures in the different departments of the health care pathway using this, figure 18, basic structure.

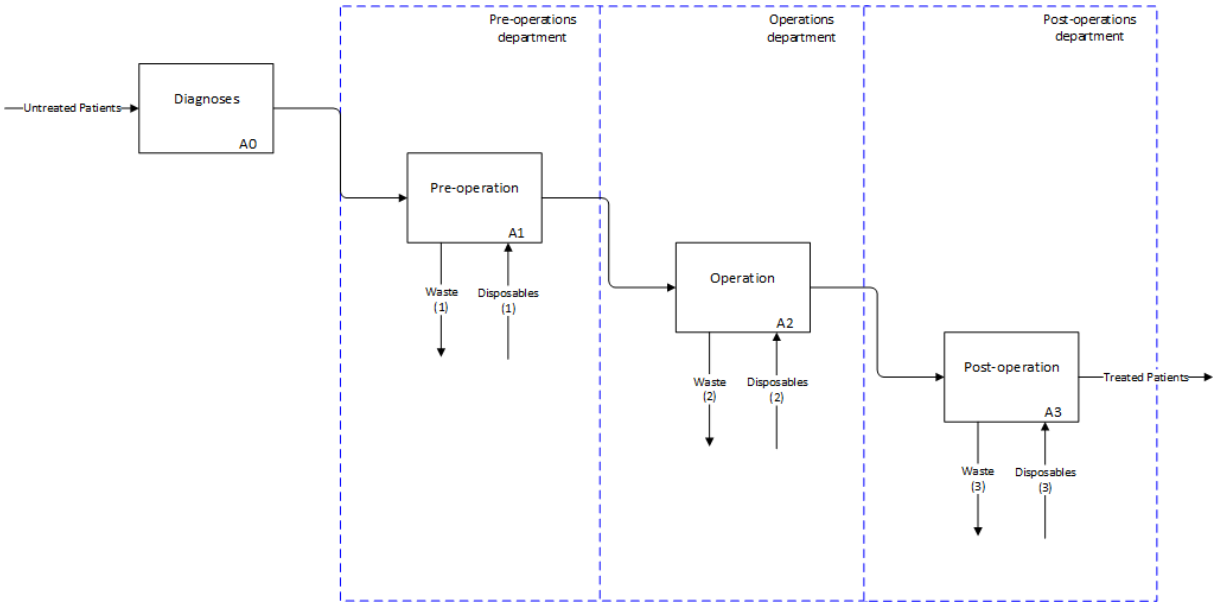

Figure 18 Basic IDEF0 diagram

5 Case Studies

5.1 Introduction

To provide answers to the research and design questions, multiple case studies are conducted. These case studies provide an insight in real life situations and the wasted disposables in these situations. This chapter will visualise the different case studies and the results derived from the case study research. Ending this chapter with a list of good and bad practices found in these health care pathways. These good and bad practices will be used in the next chapter by the construction of the framework and the proposed solutions.

5.2 Percutaneous Coronary Intervention Case study

This health care pathway has been researched in one hospital, the thorax centrum of the Erasmus MC. The Erasmus MC is an academic hospital. This health care pathway is shown in figure 19. This healthcare pathway is divided into three basic phases, the pre-operation, operation and post operation phases.

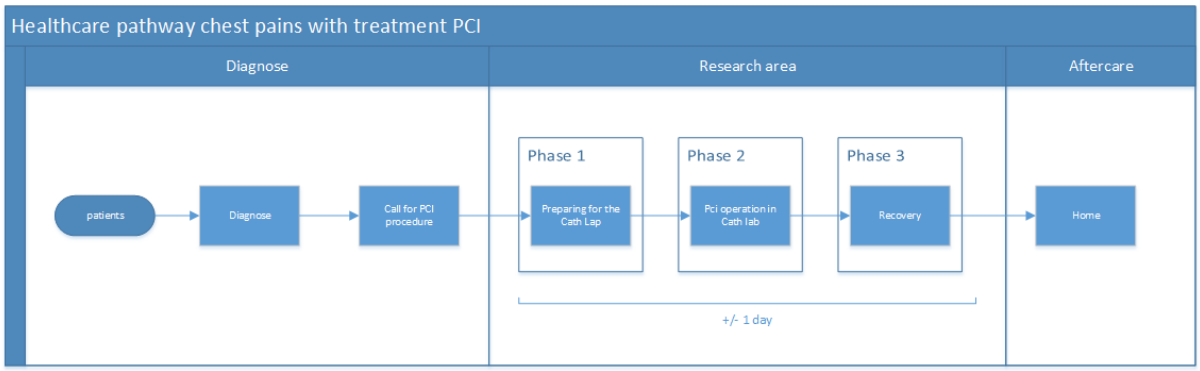

Figure 19 Schematic overview of the health care pathway PCI

5.2.1 Case study PCI: Erasmus MC

This case study research on the health care pathway PCI in the Erasmus MC in the Netherlands. This hospital has an average of 1000 patients following this specific health care pathway a year. With another 500 patients being treated in the intensive care. This health care pathway has three separate phases, within two different departments, the nursing department of the thorax centrum and the Cath Lab. In figure 20 and Appendix B1, this health care pathway is visualised in an IDEF0 diagram.

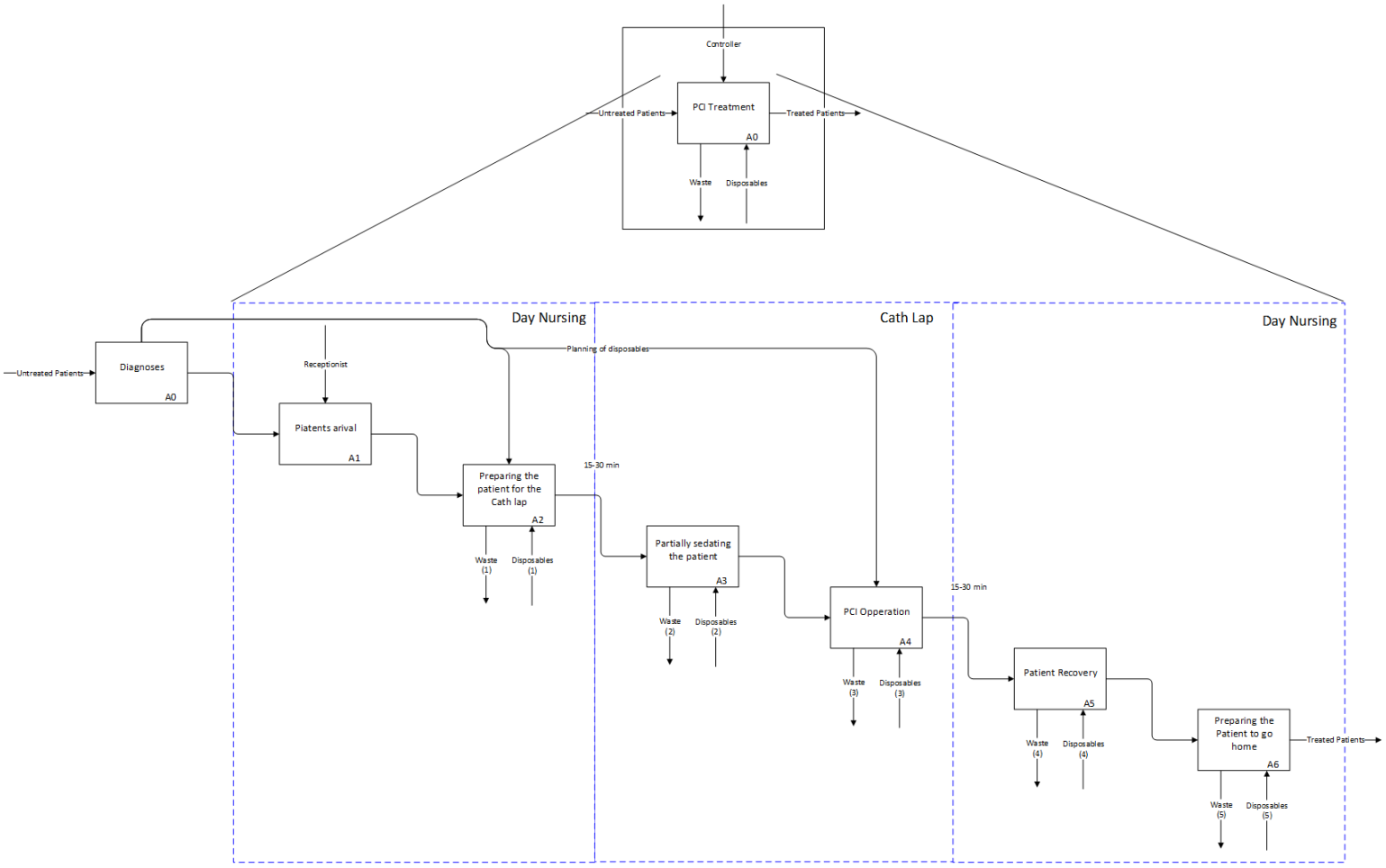

Figure 20 IDEF0 PCI operations

Table 2 Phase 1 PCI Case study

Phase 1		
Department	Nursing department	
Procedures	The patient is prepped for the PCI procedure	
Disposables (1)	ECG Patches Needle Aid patches IV Needle Fluids Meal Gloves Disinfectants Razor Total cost:	Less than 10 euro's a patient
Waste (1)	No substantial losses, because of a high throughput of the disposables and a very low cost per disposables.	
Storage and logistics	All disposables are stored in a central storage in the department. These disposables are checked daily to make sure that there is no shortest of disposables. Disposables are ordered by placing an ordering card on the	

	order wall. These order cards are daily checked. The most often used disposables in the patient's rooms are also stored in these rooms in small quantities. These are regularly check for any shortest.
Waste risks and causes	Most disposables are stored using a two bin system. One bin with the disposables that are currently used and a second bin that is used to resupply the first bin. The resupplying of the first bin is done when this bin is completely empty. At that moment the total contents of the second bin is placed in the first bin, this could also be accomplished by changing the two bins. If the second bin is empty, an order is placed to restock this bin. The chance for disposables to be wasted is slim if this procedure is done correctly.

Table 3 Phase 2 PCI Case study

Phase 2		
Department	Cath Lab	
Procedures	Percutaneous Coronary Intervention	
Disposables (2)	ECG Patches IV Needle Gloves Total cost:	 Less than 1 euro per patient
Waste (2)	No substantial losses, because of a high throughput of the disposables and a very low cost per disposables.	
Disposables (3)	Angiotray Sheath femoral/radial TR Band Wire Drug Eluting Stent/Absorbable scaffold Guiding catheter Angioseal **Total cost:**	185,38 incl. btw 6,31 incl. btw (femoral) 26,00 incl. btw (radials) 12,00 incl. btw 71,55 incl. btw 636,00 incl. btw 47,70 incl. btw 114,48 incl. btw **1061,42 incl. btw or 1733,88 incl. btw (if two stents are used)**
Waste (3)	A minimum of €20000,- a year of stents and other disposables that expire. These product expire because of many reasons. One of the main reason is the availability of newer models of disposables which are exclusively used and the older, still perfectly usable disposables, will not be used anymore and expire.	
Storage and logistics	All disposables are delivered on a card for every operation. The most often used disposables in the Cath lab are also stored in the operation rooms in small quantities. These are regularly checked for any shortest, and any disposables taken out of these stores are recorded and refilled.	
Waste risks and causes	The Erasmus MC is a academicals hospital where medical research is conducted. This includes the use of different an experimental disposables. These disposables can be wasted if they are stopped being used after completion of the experiment. Other disposables are wasted because of the previous stated reason, that the introduction of new models will reduce the use of older models. Another cause for disposables to be wasted is that all physicians want their own disposables and tools. This	

	increases the amount of different disposables stored and the chance of these disposables expiring.

Table 4 Phase 3 PCI Case study

Phase 3		
Department	Nursing department	
Procedures	The patient recovers from the PCI procedure	
Disposables (4)	Aid patches Fluids Meal Gloves telemetry bag brochure Total cost:	Less than 5 euro per patient
Waste (4)	No substantial losses, because of a high throughput of the disposables and a very low cost per disposables.	
Disposables (5)	Pamphlet Total cost:	Less than 1 euro per patient
Waste (4)	No substantial losses, because of a high throughput of the disposables and a very low cost per disposables.	
Storage and logistics	See phase 1	
Waste risks and causes	See phase 1	

Table 5 After Care PCI Case study

After Care	
Department	At home
Procedures	The patient is called after two weeks to do a remote check on the patients' health and to answer any remaining questions.

5.2.1.1 Reflection Case study PCI: Erasmus MC

The amount of wasted disposables in this case study are relatively high. The losses in the nursing department are minimized by using mostly standardized and fast moving disposables with a low cost. Every six months all disposables are checked, if these disposables are unused or rarely used they are not automatically ordered anymore. This is done to reduce the chance of disposables being wasted. The largest amount of wasted disposables can be found in the Cath Lab. An amount of 20000 euros of disposables is wasted in this department yearly, which represents around 0.5 FTE. These disposables are lost because of multiple reasons. Some of the disposables are for research purpose and are, for that reason, only partially used. Other disposables are replaced by newer models and the old models aren't used any more. These losses in the Cath Lab amount to 20000 euros.

5.3 Cataract Case study

This health care pathway has been researched in one hospital, the Maasstad hospital. The hospital is a top clinical hospital. In this hospital this health care pathway has an average build as shown in figure 21. This healthcare pathway is divided into three phases, the phases before, during and after the Cataract operation.

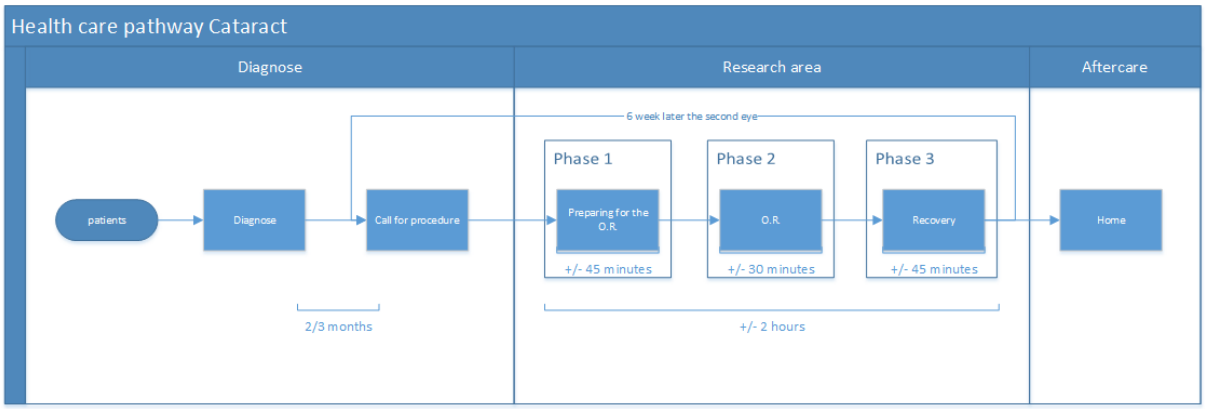

Figure 21 Cataract health care pathway

5.3.1 Cataract Case study: Maasstad hospital

This case study research on the health care pathway Cataract is researched in a top clinical hospital in the Netherlands. This hospital has an average of 2500 patients following this specific health care pathway. This health care pathway has three separate phases in two different departments, nursing department and the O.R. . The health care pathway, from

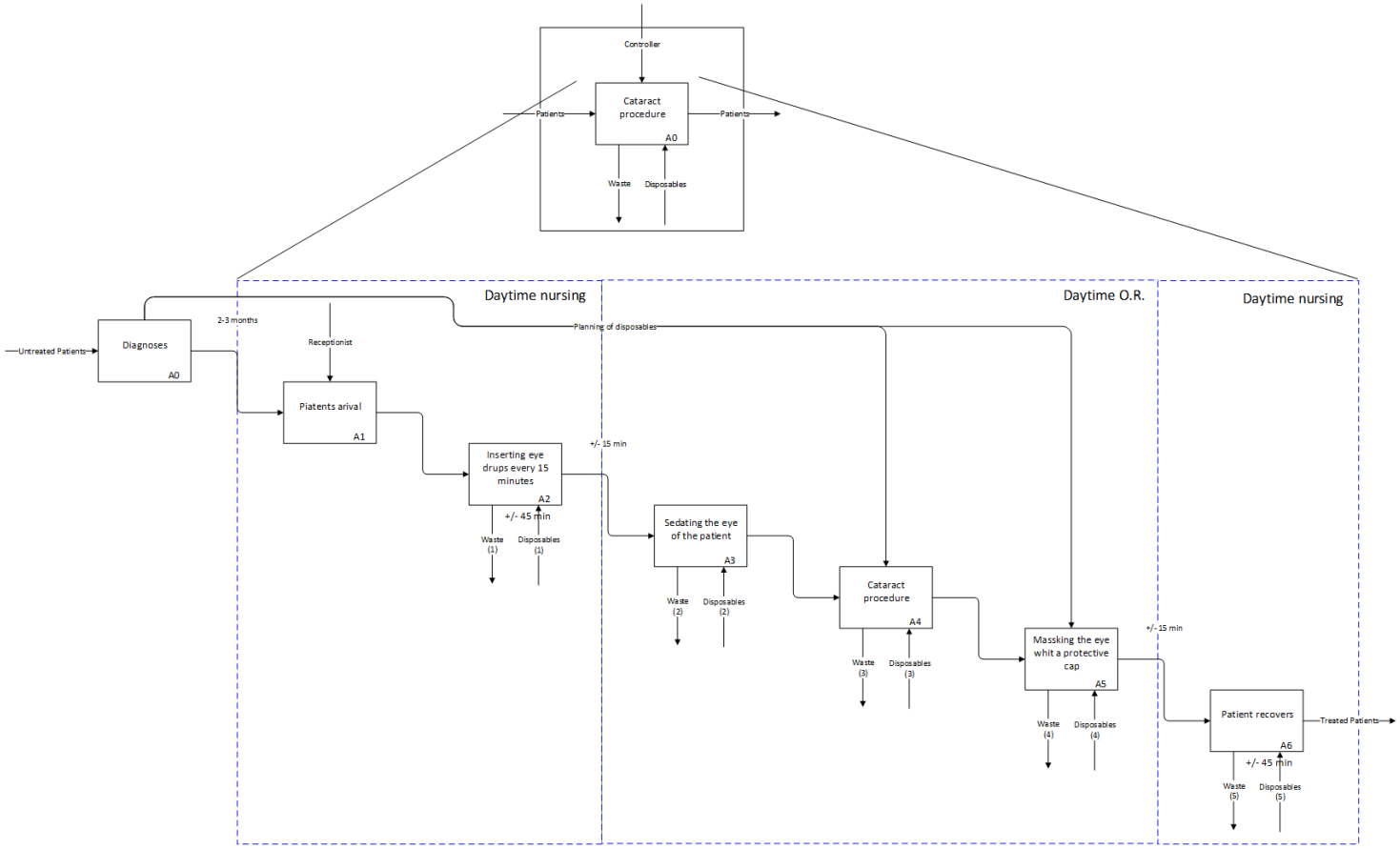

Figure 22 Cataract IDEF0

start to finish is shown in figure 22 and Appendix B2. This IDEF0 graph provides a clear images on the research area of this report.

Table 6 Phase 1 Cataract Case study

Phase 1 Daytime Nursing		
Department	Daytime nursing	
Controller	Nurses	
Procedures	The patient is prepped for the Cataract procedures with multiple eye drips	
Disposables (1)	3 times 4 types of eye drips Tissues Wadding Gloves **Total cost:**	 Less than 4 euro per patient
Waste (1)	No substantial waste, because of a high throughput of the disposables and the eye drips are packaged per use, so nothing is thrown away.	
Storage and logistics	All disposables are stored in a central storage in the department. These disposables are checked daily to make sure that there is no shortest of disposables. Disposables are ordered by placing an ordering card on the order wall. These order cards are daily checked. The most often used disposables in the patient's rooms are also stored in these rooms in small quantities. These are regularly check for any shortest.	
Waste risks and causes	Most disposables are stored using a two bin system. The chance for disposables to be wasted is slim if this procedure is done correctly.	

Table 7 Phase 2 Cataract Case study

Phase 2 Daytime O.R.		
Department	Daytime nursing O.R.	
Controller	Physician	
Procedures	Cataract procedure	
Disposables (2)	Gloves Syringe Plastic tray wadding **Total cost:**	 Less than 1 euro per patient
Disposables (3)	Eye lens **Total cost:**	+/- 92,00 **+/- 92,00**
Disposables (4)	Disposable kit **Total cost:**	+/- 100,00 **+/- 100,00**
Waste (2)	No substantial waste, because of a high throughput of the disposables and the eye drips are packaged per use, so nothing is throw away.	
Waste (3)	All lenses that would be thrown away, because of reaching the expiration date, are replaced for free by the supplier.	
Waste (4)	The disposable kit has been designed to be fully used per procedure. No disposables are lost, because the disposable kit is prepared by a separate company for every procedure.	

Storage and logistics	All disposables are stored in a movable cart. This cart has the disposable kit included, lens and all other
Waste risks and causes	If a second disposable kits is necessary, the remaining disposables are placed back on the card and used for other procedures. The possibility of wasted disposables is low If this procedure is done correctly and not to many disposables has to be restored on these card.

Table 8 Phase 3 Cataract Case study

Phase 3 Daytime Nursing		
Department	Daytime nursing	
Controller	Nurses	
Procedures	The patient recovers from the Cataract procedure with a drink	
Disposables (5)	Drink **Total cost:**	Less than 1 euro per patient
Waste (5)	No substantial losses, because of a high throughput of the disposables and a very low cost per disposables.	
Storage and logistics	See phase 1	
Waste risks and causes	See phase 1	

Table 9 After Care Cataract Case study

After Care	
Department	At home
Procedures	The patient has to come back for a diagnoses of the results after the procedure

5.3.1.1 Reflection Cataract Case study: Maasstad hospital

In the health care pathway of Cataract only a small amount of disposables are used for the patient. The disposables that are used are largely standardized. In the day nursing department all disposables are stored in the central storage that is checked regularly. The disposables in the O.R. are stored on a special cart and delivered just in time. This practice is similar to the Lean Six Sigma method as mention in chapter 2.4.3. The reason for storing the disposables on this cart is because the O.R. is used for multiple procedures which all need their own disposables. If this practice would not be done, a large amount of disposables would have to be stored in the O.R. for the different operation. Such a large amount of different disposables in one storage can have large repercussions on the amount of wasted disposables. All disposables on the cart are checked regularly, and the cart is checked during every session. If not all disposables from the disposable kit are used during the procedure, these left over disposables are stored in the cart as backup. This concludes that only a small amount of disposables are lost, and that the cost of these losses is very limited.

5.4 Hip fractures Case study

This health care pathway has been researched in two hospitals, the Maasstad hospital and Beatrixziekenhuis of Rivas. The Maasstad hospital is a top clinical hospital and the Beatrixziekenhuis is a regional hospital. In these hospitals this health care pathway has an average build as shown in figure 23. This healthcare pathway is divided into four phases, the phases before, during, and after the Hip Fracture operation and the preparation for the aftercare.

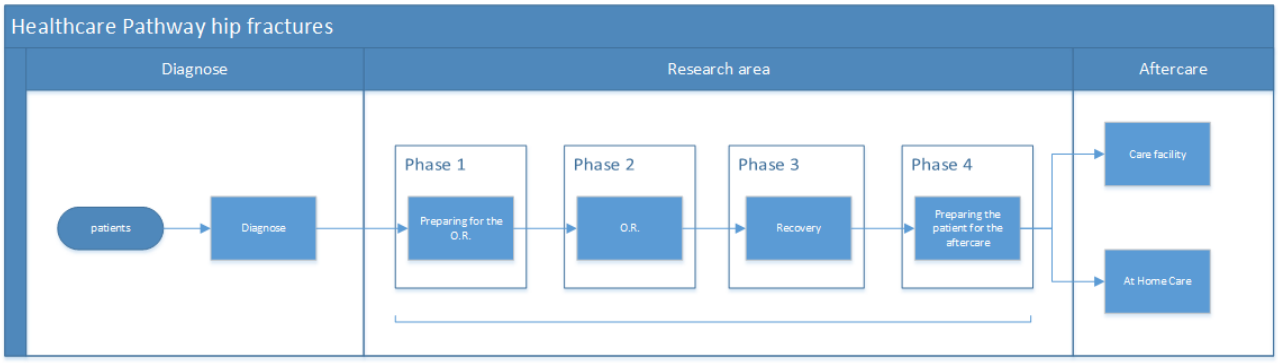

Figure 23 Hip Fracture health care pathway

5.4.1 Hip Fracture Case study: Maasstad hospital

This case study research on the hip fracture health care pathway in a hospital in the Netherlands. This hospital has an average of 450 patients following this specific health care pathway. This health care pathway has three separate phases in three different departments, the nursing department, recovery room and the O.R. . The health care pathway, from start to finish is shown in figure 24 and Appendix B3. This IDEF0 graph provides a clear images on the research area of this report.

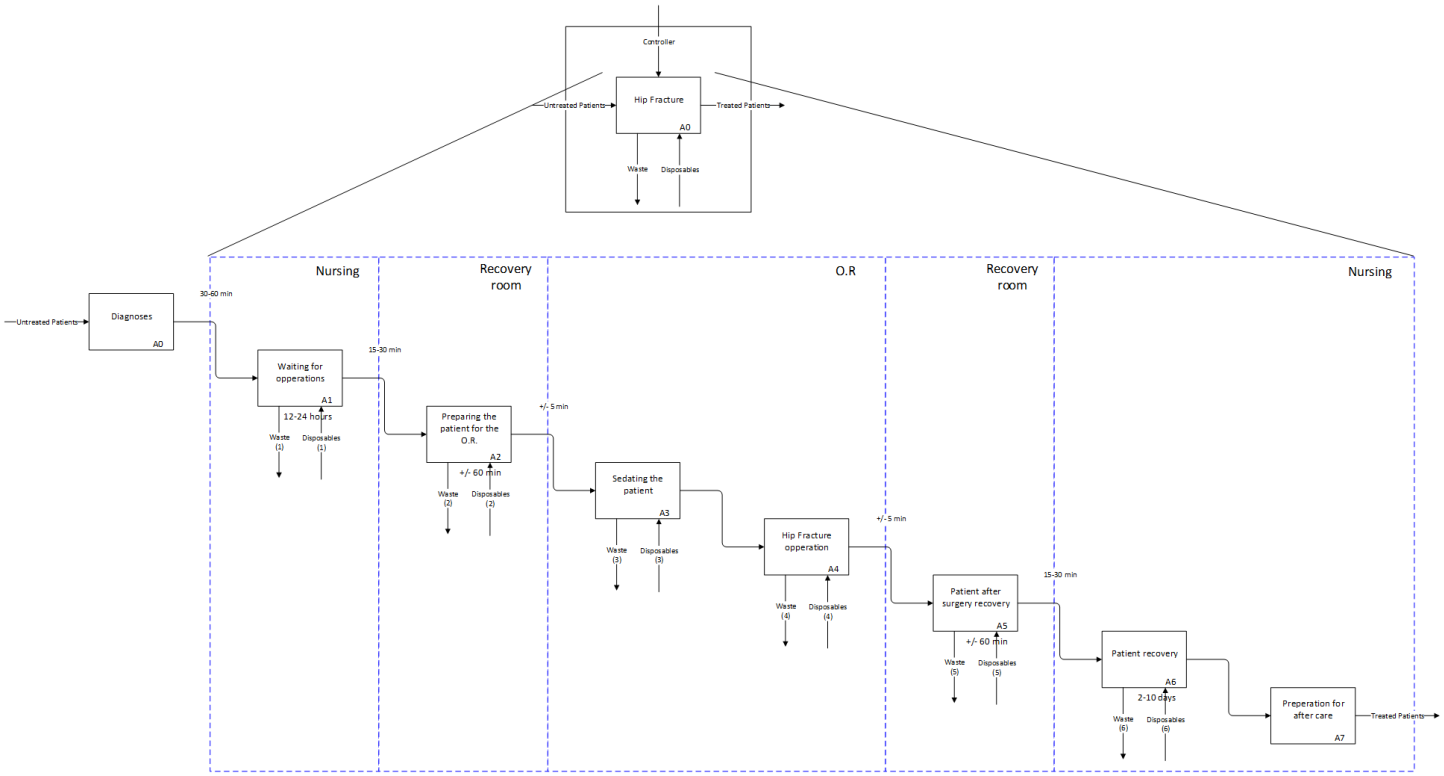

Figure 24 IDEF0 Hip fracture

Table 10 Phase 1 Hip Fracture Case study

Phase 1 Daytime Nursing		
Department	Daytime nursing	
Controller	Nurses	
Procedures	The patient is prepared and kept in waiting for hip fracture operation	
Disposables (1)	Drinks Food Personal health care products **Total cost:**	 Less than 5 euro per patient
Waste (1)	No substantial waste, because of a high throughput of the disposables so nothing is thrown away.	
Storage and logistics	All disposables are stored in a central storage in the department. These disposables are checked daily to make sure that there is no shortest of disposables. Disposables are ordered by placing an ordering cart on the order wall. These order carts are daily checked. The most often used disposables in the patient's rooms are also stored in these rooms in small quantities. These are regularly check for any shortest.	
Waste risks and causes	Most disposables are stored using a two bin system. The chance for disposables to be wasted is slim if this procedure is done correctly.	

Table 11 Phase 2 Hip Fracture Case study

Phase 2 Recovery Room		
Department	Recovery Room	
Controller	O.R Nurses	
Procedures	The patient is prepped for the hip fracture operation	
Disposables (2)	Styles **Total cost:**	 Less than 1 euro per patient
Waste (2)	No substantial waste, because the disposable will be used for multiple patients.	

Table 12 Phase 3 Hip Fracture Case study

Phase 3 O.R.		
Department	O.R.	
Controller	Physician	
Procedures	Hip fracture operation	
Disposables (3)	Gloves **Total cost:**	 Less than 1 euro per patient
Disposables (4)	Stitches Hip replacement Wadding **Total cost:**	< €1 +/- €2500 < €1 +/- €2500
Waste (3)	No substantial waste, because of a high throughput of the disposables.	
Waste (4)	The hip replacement is delivered just in time for the operation and has a long shelf live, which reduces the amount of wasted goods close to zero.	

Storage and logistics	Most disposables are stored in a movable cart. This cart has the disposable kit included, lens and all other. Some disposables are stored in the operation rooms in small quantities. These are regularly check for any shortest.
Waste risks and causes	If the amount of different disposables stored for this procedure is large, the change for any of these disposables to be wasted is great. Because different physicians require different disposables for similar procedures, the amount of disposables could possibly be on a level that some of those disposables are wasted.

Table 13 Phase 4 Hip Fracture Case study

Phase 4 Recovery room		
Department	Recovery Room	
Controller	O.R Nurses	
Procedures	The patient is left to recover for around an hour.	
Disposables (5)	**Total cost:**	none
Waste (5)	No substantial waste, because there are no disposables used	

Table 14 Phase 5 Hip Fracture Case study

Phase 5 Daytime Nursing		
Department	Daytime nursing	
Controller	Nurses	
Procedures	The patient has to recover for some days, the total time that the patient resides in this department depends on the health status of the patient and the after care options. The total stay is between 2-10 days.	
Disposables (6)	Drinks Food Personal health care products **Total cost:**	Less than 5 euro per patient per day
Waste (6)	No substantial waste, because of a high throughput of the disposables so nothing is thrown away.	
Storage and logistics	See phase 1	
Storage and logistics	See phase 1	

Table 15 Phase 6 Hip Fracture Case study

Phase 6 Daytime Nursing	
Department	Daytime nursing
Controller	Nurses
Procedures	The patient is prepared to leave the hospital and move to after care, at home or in another facility.

Disposables (6)	Information leaflet **Total cost:**	Less than 1 euro per patient
Waste (6)	No substantial waste, because the information leaflet has an expiration data that only depends on the correctness of the data.	
Storage and logistics	See phase 1	
Waste risks and causes	See phase 1	

Table 16 After Care Hip Fracture Case study

After Care	
Department	At a care facility or a home with home care
Procedures	The patient has to recover and do physiotherapy to improve hip function

5.4.1.1 Reflection Hip Fracture Case study: Maasstad hospital

The patient will resides within the health care pathways of hip fractures for multiple days. For most of these days, the patient will stay in the nursing department. The disposables that the patients will use on an average day in the nursing department are highly standardized and have a high throughput rate. This results in a close to zero amount of wasted disposables are produced by the nursing department. During the patients stay at the hospital, a relatively small time is spend in the operation room for the medical procedure. In this procedure, more expensive disposables are used. These disposables are delivered just in time, specifically for the procedure and these goods have in average a long shelf life. This implies that the amount of wasted disposables, in the operation, is close to zero.

5.4.2 Hip Fracture Case study: Beatrixziekenhuis

This case study research on the hip fracture health care pathway in a general hospital in the Netherlands. This hospital has an average of 100 patients following this specific health care pathway yearly. This health care pathway has three separate phases in similar departments as in the hip fracture case study Maasstad hospital. Because of the similarities between this case and the case study Maasstad hospital the same figures and appendix are used, figure 24 and Appendix B3. The results within the different phases of this health care pathway match the results of the top clinical health care pathway. For that reason the IDEF0 and corresponding tables will not be repeated.

5.4.2.1 Reflection Hip Fracture Case study: Beatrixziekenhuis

The patient moves similarly through the health care pathway as the one in the top clinical hospital, the Maasstad hospital. The difference between the two case studies is the method of the goods logistics. In the Beatrixziekenhuis, all goods and disposables are delivered and checked by the logistics department. The ordering system is based on a min-max system. In this system all goods that are ordered regularly are within this min-max system. In this system goods are ordered if the amount available in the local storage is smaller than the minimum amount stated, and never more than the maximum amount. This system lets logistics staff control and order the needed goods, but could also create waste. In this

system the newer goods can be placed in front of the older existing stock, this would mean that the older stock is in danger of being wasted.

In this hospital, the O.R. department has its own locale storage of goods. In this storage all regularly used goods are stored here and collected by O.R. staff when needed for a procedure. The storage system used in the O.R. department is similar to that of the other department, a min-max system. The costs of disposables in the O.R. are in average higher than that of most other departments, which makes the waste more costly.

While there is a logistic system in use in this hospital that has a chance to create waste, the amount of waste found in the health care pathway hip fractures is close to zero. This is because the amount of disposables used in this health care pathway is limited and standardized. The most expensive disposable used in this health care pathway is the hip prosthesis, which has a long shelf live and ordered for the specific procedure.

5.5 Case study results and review

The different case studies all provide a very similar image. In the different health care pathways only a very small amount of losses of disposables can be found. The reason for this waste is that health care is done by and on people, which makes it less than perfect and some losses are then reasonable. The costs to reduce these small losses to zero are so high that it does not compensate the profits of doing this. In one of the health care pathways this reasoning was false. In this health care pathway 20000 euros of wasted disposables are yearly lost.

Table 17 Case study results

Case study	Amount of wasted disposables
Case study PCI: Erasmus MC	20000 euros of wasted disposables yearly
Cataract Case study: Maasstad hospital	No substantial waste of disposables
Hip Fracture Case study: Maasstad hospital	No substantial waste of disposables
Hip Fracture Case study: Beatrixziekenhuis	No substantial waste of disposables

The case study of *PCI: Erasmus MC* is the one study that is the exception on the rule that there are no substantial wasted disposables in the researched health care pathways. In this health care pathway, in the Cath lab, an average of 20000 euros of disposables are yearly wasted. The disposables that are wasted in this department consists mostly of stents and catheters. These are the more specialised and expensive disposables used in this health care pathway. The reason for these wasted disposables is, as previous stated, because of a lack of standardization and a misuse of older but still functional models. This pathway is seen as an exception, because it is in an academic hospital where research is conducted, which is partly responsible for the wasted disposables. In all other health care pathways, and in the nursing department of the *PCI: Erasmus MC* the amount of wasted disposables is close to zero.

Waste causes

The waste found in the researched health care pathways is very limited. But some of the procedures do have a risk included that could lead to the wasting of disposables. The main waste research is that of expiration of disposables. This happens when disposables are stored longer than expected. This could happen when a large amount disposables is stored, to many different type of disposables with similar health care aims are stored or when a newer model reduces the use of an older model disposable. Another reason for disposables to be wasted, is not using the stored disposables on a first in first out (FIFO) bases. This could happen when the resupplying of disposables is not done according the stated procedures.

5.6 Good and bad practices

In the different health care pathways researched in this report multiple methods are used for the handling and use of disposables. Some of these methods used can be defined as positive for decreasing the amount of losses of disposables, while others have a negative effect. These good and bad practices are summed up in this paragraph. Both good and bad practices are helpful for improving the existing health care pathways disposable uses. The insight into these practices came from interviews with logistic managers, hospital employees and in the field research.

Good practices

- Standardizing of disposables, especially in the nursing department
- Regularly checks on disposable stored and their shelf lives
- Regularly discussion on which disposables to keep in storage and which to specially order for special situations
- Delivering disposables just in time and specifically for the procedure.
- Standardization of disposables used for a procedure

Bad practices

- Leaving the old model disposables unused, when a new model disposable is available.
- Lack of standardization within some operation rooms.
- Not all disposables are ordered with the hospitals ordering tool, which reduces transparency and increases waste potential.
- Procedure faults that compromise the first in first out practice.

6 Health care pathway framework

6.1 Introduction

Health care pathways exists for many different health care procedures. As described in the previous chapters, different practices for the goods logistics within these health care pathways exists. This chapter will provide a standardized framework of a general health care pathway, based on the basic framework as descripted in chapter four. This framework provides a structure to compare and benchmark different healthcare pathways and reduce disposable waste. This framework is based on the data researched in the previous chapter. This chapter starts with a recap of the generalized health care pathway structure. This structure will be used to provide a set-up to the framework.

6.2 Framework

The framework created in this research will be divided into the three steps of the health care pathways, the pre-operation, operation and post-operation steps. This framework will describe the main waste reduction solutions per step and which actors are involved to implement these solutions. This framework provides simple and practical solutions to reduce the possible wasted disposables, based on the good and bad practices found in the case studies and the actor analyses.

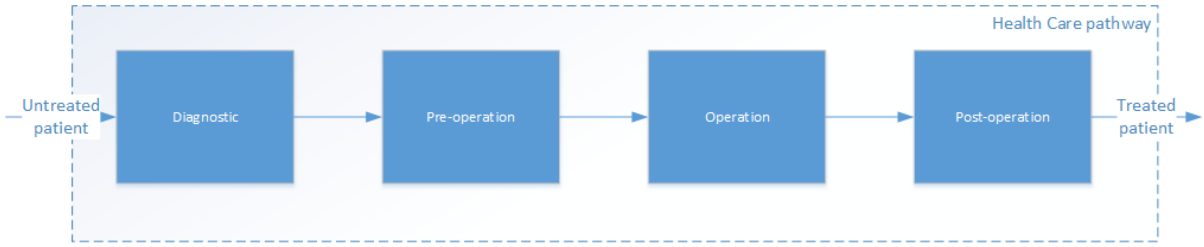

Figure 25 Basic health care structure

6.2.1 Pre-operation

The pre-operation step of a healthcare pathway is often situated in a care ward of the hospital. In this department patients wait and are prepared for the operation. Some care wards are for specific health care pathways, but often this is not the case. In these instances, the patients within the care ward are waiting there for different operations or procedures. In both cases, different disposables are needed. In the case if the ward is specifically for one health care pathway, any disposable reduction methods has to focus only on the specific health care pathway. If the ward is for multiple different patients groups with different health care needs, any disposable reduction methods needs to be implemented on a department or hospital level.

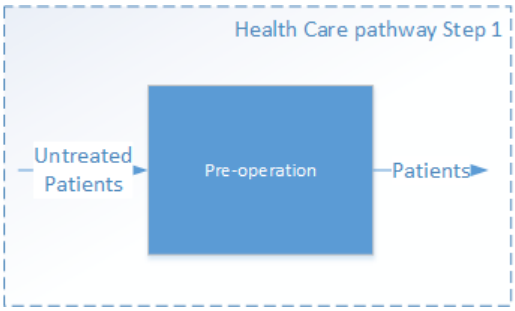

Figure 26 Pre-operation framework

Any disposables needed by the ward are stored in locale storages in this ward. There are different methods to resupply these storages, but the preferred method should make sure that the disposables are used on a first in first out bases. This would ensure that the disposables are not wasted within the storages. A preferred method to ensure this first in

first out method, is the use of a two bin system. In this system any disposable is stored in two bins, one for use and the other as storage. If the bin for use is empty it is resupplied by the storage bin and the new disposables are placed in the storage bin. This system is a simple and effective method to use, both by the supplier and user side of this system.

Planned health care pathways

The amount of patients, and their health care needs, are highly predictable in planned health care pathways. The disposables needed in these health care pathways can also be predicted. The predictability of these disposables depends on the information that is shared within the system and the standardization (Samantha Zarzuela, 2014) of the needed disposables for the average patient. If the patients' health care needs in a health care pathway can be standardized to one or a few different groups, the disposable needs per patient can be standardized. The distribution of disposables can be optimized if the need is set and standardized.

Non-planned

In non-planned health care pathways, the distribution of disposables is a lot harder to optimize. The main solution, to minimize the amount of wasted disposable, is to standardize the used and stored disposables. These disposables should be standardized per type of disposable, throughout the department or hospital. This would reduce the need of a large amount of disposables stored within the department. The amount of stored disposables can further be optimised by using data from the past to try to predict the need of disposables in the future.

Waste reduction solutions

The main solutions to reduce the amount of waste within this step of the health care pathway are:

- Standardize the disposables used and stored in this health care pathway
- Standardize the use of the same type of disposables throughout the hospital, use one or a few models per disposable type.
- Optimize the distribution of disposables by using demand prediction or known patient planning
- All disposables should be used in a first in first out method (FIFO).

Implementation

To implement the stated solutions within the system, the actors involved in this part of the system have to be directed to change. The main actors involved in this step of the health care pathway are the nurses and department manager. And if the solution is implemented throughout the hospital, the hospital management is also one of the main actors. The interest, in the reduction of wasted disposables, from both the department manager and the hospital management is based on the amount of financial gain. The nurses, the party that has the direct connection with the patient and the disposable use, have to be persuaded to change. This could be done by implementing a part of the financial gain back in the system to improve the working situation of the nurses.

6.2.2 Operation

The operation step of the health care pathway is mostly done in a operation room or a similar department. These rooms are specialised rooms optimised for a medical procedure on, most often, a single patient. Because of the level of sterilisation needed in these rooms, the cost for the use and maintenance of these rooms is high. The medical procedures conducted in these rooms are specialised and the disposables needed are also often specialised for these procedures. This ensures that the average cost for disposables used is higher than that of the pre- and post-operation steps.

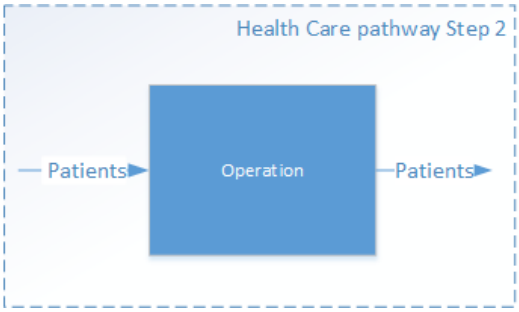

Figure 27 Operation framework

Planned health care pathways

Similar to the pre-operation step, if the procedure is planned and the disposable need is pre-determined, the distribution can be optimized. The difference between the two steps is that the cost for storage space and the costs for O.R. staff operation time is higher. This implies that the goods logistics is differently organised in this department. The amount of storage is minimised and the disposables are stored in close proximity of the operation table. In planned health care pathways disposables can be delivered just in time and in standardized packages or kits. If these disposables are stored on a transportable storage, a cart, this storage can be optimized for the specific operation and situated close to the operation table. Both solutions would reduce the amount of waste, both of disposables and of staff operation time, and create a Lean health care pathway.

Non-planned

Before the operation step of the health care pathway, the patient is already been within the hospital for some time, which reduces the unpredictability of these health care pathways and their needed disposables. To reduce the effect of the still unpredictable demand of disposables, the needed disposables should be standardized per type and operation as much as possible. Disposables should be delivered just in time and stored in another storage than the O.R. storage. This would result in a similar reduction of waste as the planned health care pathways.

Waste reduction solutions

The main solutions to reduce the amount of waste within this step of the health care pathway are:

- Standardize the disposables used in this health care pathway, preferably in disposable kits per operation per patient.
- Standardize the use of the same type of disposables throughout the department or hospital
- Deliver disposables just in time on transportable storage, to reduce the amount of storage within the O.R. department.
- When the standard type of disposable is changed, because there is a newer model or another supplier, the old standard type of disposable should first be used until the stock of this disposable is empty.

Implementation

Similar to the pre-operation step, to implement these solutions in the system, all actors involved have to be persuaded to change. The difference between the two steps is that in the operation step, one of the main actors are the physicians (Ellingsen, 2004). The physicians are often independent entities who are not direct staff members of the hospital. To implement the solutions in this step of the health care pathway is to make the physicians responsible for any waste created by deviation on the standardized disposables or by making the physician a full-fledged staff member of the hospital.

6.2.3 Post-operation

The post-operation step of the health care pathway is often situated in the same or a similar care ward as the pre-operation step. This step is similar to the pre-operation step both in disposables used and the solutions to reduce possible waste. There are two main differences between the two steps. Firstly, the patients will have moved through the system for a longer time than in the pre-operation step. This means that in this step almost all health care pathways can be seen as planned health care pathways. And the waste reduction solution proposed in the pre-operation step for planned health care pathways can be used. Secondly, after this step the patient will leave the hospital and go to their home or a after care facility. If the information on when a patient will leave the hospital and what types of disposables are needed for this patient is shared in advanced with the after care facility or organisation, these facilities and organisations can plan and optimize their logistics of disposables. This would improve the waste reduction of disposables on a general health care system level. This can only be implemented when the different parties involved communicate clearly and collaborate.

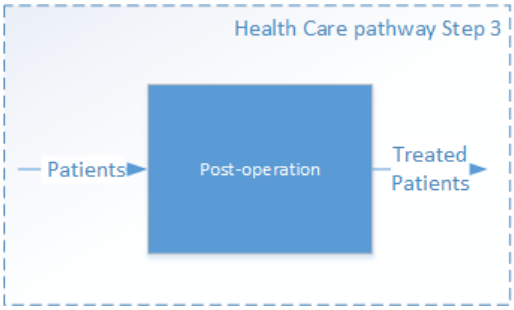

Figure 28 Post-operation framework

6.3 Framework overview

There are multiple different health care pathways within hospitals. All these health care pathways use disposables and there is the chance that these disposables are wasted. This framework provides methods to reduce this potential waste. In figure 34, the solutions described in the previous paragraphs per health care pathway step are stated. These solutions focus on these specific steps, but there are also some solutions that work best on a system level. The first and main point needed for change within a multi actor environment is communication and collaboration between actors involved. To optimize the disposables distribution and reduce waste, the amount of disposables needed and used has to be known. This knowledge is inherently connected to the health care demand of the patients. If the parties within the system communicate, the knowledge of the amount of patients, what they need , where they are and where they will be in the near future, is clear for all parties involved. With this knowledge, both the goods logistics can be optimized and possible waste reduced.

Even when communication is optimized, some of the demand can still be hard to predict,. The disposables needed for these emergency procedures have to be stored within the hospital. To minimize this storage, all disposables of the same type should be standardized,

for every type of disposable. This can be done on a department level, but most gain comes when this is implemented on hospital level.

Lastly, there is a theoretically simple but unpractical solution to reduce the waste of disposables. If all disposables where tracked and traced, no disposables have to be wasted. This track and tracing of disposables is already done on a small scale with expensive disposables in some hospitals. To track and trace the disposables, the information on these disposables have to be stored in a computer software system, from where it can be updated and monitored. This could ensure that no disposables are wasted or expire. This is unpractical to implement in a hospital, because the cost of imputing and monitoring all the data would be too high. This solution is not future investigated in this report because of the solution being unpractical at the writing of this report.

The proposed solutions to reduce the chance of wasted disposables are similar to the Lean Six Sigma method used to reduce waste and variation. In other industries, the Lean Six Sigma method (Binnerts) has proven to be an effective method to reduce waste and lower costs. This framework is constructed with the same purpose as the Lean Six Sigma method and uses similar solutions.

This framework, as shown in figure 29, provides an overview on which existing health care pathways can be tested and improved with.

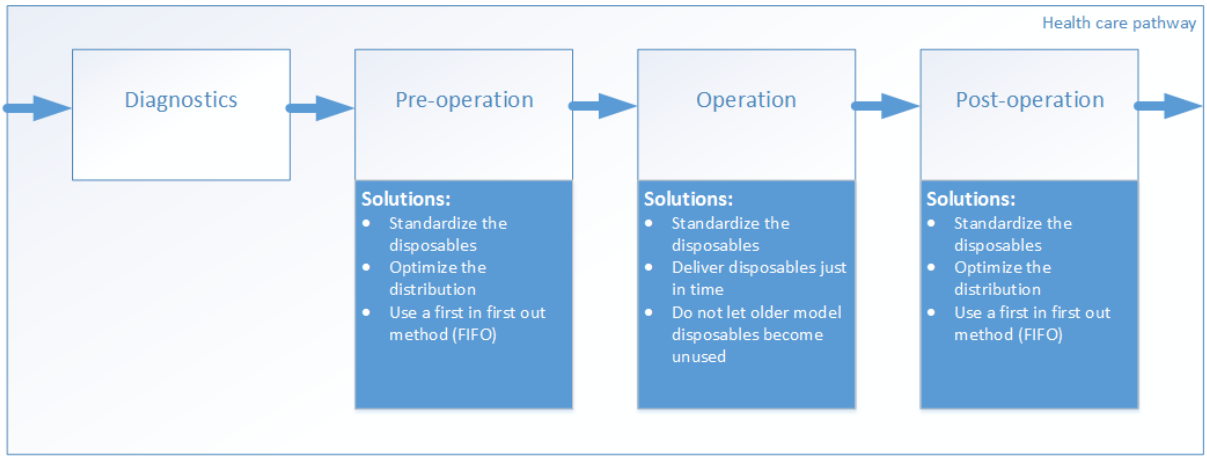

Figure 29 Framework overview

6.4 Framework verification

The framework created in this report is based on the research data acquired from both the literature study and the field research. To verify the framework constructed in this report, a plan is constructed for the implementation in a health care pathway and the expected results. If these expected results do not match with the real life results, this framework has to be changed or rejected.

6.4.1 Framework implementation plan

When implementing the framework in a health care pathway, all recommended solutions should be implemented to get the most optimum results. The main step to facilitate change, is to convince all parties involved to adopt the proposed change. Most parties involved should be contributors to this change, especially the parties that have to implement these

solutions in the system. After completing this step by convincing all parties, it is possible to implement impactful and permanent change.

The two solutions and effect of these solutions are shown in table 18. This table will visualize generalized solutions and generalized effects.

Table 18 Implementation solutions framework

Solution	Effect
Standardize disposables, both stored and used	By standardizing disposables, less different disposables have to be stored. This will improve the throughput of the remaining disposables. Because of both effects, the amount of possible wasted disposables will be reduced. Another effect is the reduction of possible storage space needed
Optimize distribution of disposables using patient flow information	By optimizing the distribution of disposables to the patient flow, the amount of goods stored will be reduced and the time that these disposables are stored on shelves decreased. These two effects both reduce the amount of possible wasted disposables and the needed possible storage space.

The effects described in table 18 are not always the effects realised in real life health care pathways, when the solutions are implemented. If standardizing does not reduce the amount of different disposables within storages, this could mean that the disposables are already standardized optimally. Similarly, if the needed disposables within the health care pathway is highly variable per patient, the optimization of disposables distributed will have a limited effect.

If the described effects are not realized in real life health care pathways , the reason for these not realised effects should be determined. If the reason for not achieving the predicted effects is not previous stated and commonly happens in other health care pathways, then the framework constructed in this report has to be (partly) rejected.

7 Conclusions and Recommendations

7.1 Introduction

The different previous chapters of this report all lead to conclusions and recommendations. This chapter will provide these conclusions, recommendations and answers to the research question. Firstly, the conclusions will be stated, these conclusions will answer the previous stated research questions. After these conclusions, and derived from these conclusions are the recommendations.

7.2 Conclusions

No wasted disposable where found within a large percentage of the health care pathways researched. One part of a single healthcare pathway was found to be an exception on this rule, the Cath lab of the health care pathway PCI. That no wasted disposables are found in a large percentage of health care pathways researched can be explained on three levels, the optimized goods supply chain, the understanding of the actors involved in the problem and the standardisation of procedure and disposables. These optimized health care pathways provide both good and bad practices used for the health care pathway framework to reduce possible wasted disposables.

The good logistics supply chain within the Dutch hospitals is based on a pull mechanism, the demand of the different healthcare departments determine the amount of goods transported. The disposables, part of the goods supply chain, are ordered by the different departments using largely a computerised ordering portal. These disposables are then ordered from the central storage or directly from the supplier. Because of the costs and limited space for storage, most disposables are ordered when the storage is almost empty or when they are needed for a specific operation. Another cost efficient practice that is being implemented is the standardisation of disposables within a hospital. This reduces the number of different disposables with the same function within storage, and reduces the possibility of less used disposables being wasted. The amount of wasted disposables within the supply chain is small and has largely one specific cause, human error.

To solve problems within a system with multiple parties, the parties with the most power and interest have to be found and persuaded to help solve the problems. When looking at the health care system on macro scale, the parties that have the highest power and interest are the health care facilities and health care insurance companies. The health care insurance companies have a lot of power because they provide the finances. Any cost reduction in the health care system will reduce the amount of finances the health care insurance companies have to provide. The health care facilities have the most interest because a reduction of waste, which originate within their own organisation, will reduce their costs. A third party which has a lot of power, is the government which provides the rules and regulations which all other parties have to oblige by. On the micro scale, the power and interest within a hospital is quite different. One of the most powerful party within a hospital are the different physicians, while the different department managers and logistic managers have the most interest in solving the problem. Because the power of the physicians within the hospitals is reducing and the importance of cost reduction is increasing the last years, space for more cost efficient solutions within the hospitals can be found.

The different health care pathways in the Dutch Hospitals all use their specific disposables. The three health care pathways researched in this report, cataract, hip fractures and PCI, are all health care pathways that have a relatively high patient throughput with mostly one type of patients. These health care pathways are largely standardized, both in procedure as in disposables used. The disposables used in these health care pathways are also mostly standardized and have a large throughput, similar to the patient's throughput of these health care pathways. This is most apparent in the nursing and care departments. In these departments the throughput of the disposables is at such a high level that most disposables do not have a chance to expire. This statement is only true if the less used disposables are not stored in large quantities. Because of the high level of standardization and regular checks the statement that no disposables are wasted is true for these nursing and care departments. In the departments where the medical procedure takes place, O.R. or Cath Lab, the amount of wasted disposables is higher, compared to the nursing and care departments. This is partly because of using disposables with a higher average cost, small losses of these disposables creates higher costs. Another reason for a higher amount of losses is that in these procedures a smaller level of standardization can be realized. While the losses in these specialised departments are higher than that of the nursing departments, only in one case these losses are significant. The losses within the other cases can be explained by human error, which cannot be prevented.

The one case in which losses are found, is the Percutaneous Coronary Intervention procedure of the Erasmus MC. In this health care pathway a yearly total of €20000,- of wasted disposables is found, within the Cath lab department. The disposables that are wasted consisted mostly of specific stents and catheter. Part of the losses can be assigned to academic research, but also to the misuse of disposables. An example of misuse is letting older, but still perfectly useable models, become wasted because a newer model is available.

As previously stated, the researched health care pathways are mostly very standardized and have mostly one type of patient. These factors support the conclusion that only a limited amount of wasted disposables are found in these health care pathways. Because of this standardization, all steps within the health care pathway are generally optimized. Further optimization of the use and delivery of disposables in these health care pathways can be done by using the data and information from the previous used disposables. With this data, all disposables that do not have to be stored in the different departments can be delivered just in time, which reduces the amount of disposables stored and the chance of these disposables being wasted.

As shown in the framework, which is constructed in this report, the main solutions to reduce waste is to standardized the stored and needed disposables and optimized the goods supply chains in all health care pathways. This would reduce the amount of goods stored in the different departments and would reduce the possible wasted disposables. Which in turn will reduce the costs. The implementation of this framework, which is based on the research of this report, is only possible with good planning and communication within the total system. Because change within a multi actor environments is only possible if there is communication and collaboration between actors.

7.3 Recommendations

This report shows that almost no disposables are wasted within the researched health care pathways. These health care pathways, which are standardized, are researched in a few Dutch hospitals. To create broader and more founded results, on the wasted disposables in health care pathways in Dutch hospitals, some subsequent research studies have to be explored. The subsequent research studies that are recommended to be conducted are:

- A subsequent research study where the results from the health care pathways researched in this report are compared to the same health care pathways within other Dutch hospitals. This study can demonstrated if the results derived from this report are representative to the average results or if the results derived in this report are a best practice. If it turns out that the results derived in this report are a best practice, than these results can be used as an example to direct a system wide improvement. This study can be done by conducting multiple interviews with the specific health care specialist within other Dutch hospitals or by the use of a questionnaire.
- A subsequent research study that will research if the results concluded in this report are applicable to both standardized health care pathways and less standardized health care pathways. This study will show if the reported results are applicable to more healthcare pathways than the ones researched. This study should focus on the differences between the health care pathways and if these differences have an effect on the wasted disposables. This study should have a similar setup as the setup of this research report.
- A subsequent research study that verify the applicability of the framework on health care pathways. This study will have to implement the waste reduction solutions on a health care pathway, or find a health care pathway were these solutions were implemented with data on the effects of these implementations. The effects found in this study should be similar to the effects described within the implementation plan of the framework. This study will provide a foundation on the quality and the applicability of the constructed framework.

If the subsequent research studies provide similar results as this report, the correctness of the assumptions made in this report are verified. The results of these subsequent studies, together with this report, will provide a clear image on the wasted disposables in the health care pathways in the Dutch hospitals. This can even be extended to the care system, if similar studies will be performed in the after care sector.

8 Comments

This research thesis provided some important lessons to be learned for future research. These lessons came from the setbacks encountered during the research for this report. The main issue was the difficulty to do research in a multi actor environment. All these different parties have their own priorities and limited time, which makes this research thesis time consuming and difficult to accomplish. The writing of this report was also slowed down because of the writer of this report being dyslectic.

At the start of this research, the health care pathways that are most relevant and practical to be researched were defined by two interviews with health care pathway specialists. In the first of the two interviews, five different health care pathways where chosen to be researched. This amount of five health care pathways was requested by the supporting lectures and professor of the TU Delft at the start of this research. This amount of five health care pathways was reduced to four within the second interview. The health care pathway of appendicitis was not deemed, by the health care specialist, as relevant for this research. This because this health care pathway is standardized and identical between and within hospitals. Because of the high level standardization, the health care pathways is predicated to have very limited waste. The exclusion of one health care pathway was not a reason to include a new one, because the time and difficulty to research five health care pathways was deemed too much for the planned amount of time.

The remaining health care pathways were planned to be researched in multiple hospitals. This was proven impossible, because of the limited amount of hospitals that participate in this research. Most parties could or would not make time for this research. Beside this, most parties found it hard to find the person responsible for the disposables within the stated health care pathways. These factors combined ensured that this research took a lot of time and that the amount of interviews and in the field research was limited. The three hospitals, Erasmus Mc, Maasstad hospital and Rivas, were able to provide support and time for this research. They provided the needed and much appreciated information to construct both the case studies and framework.

At the end of this research, three health care pathways could be researched. This ensured that the research report had to be adopted to provided structured and supported end result. This changed the direction of the report to creating a framework to provide a framework to reduce the wasting of disposables in health care pathways, based on the good and bad practices found in the researched health care pathways. This new approach reduced the amount of different actors that had to participate in this research. Because finding parties prepared to provide help for a project that they do not prioritise is difficult, both while doing research or implementing solutions in the system. This concludes this thesis report with the final remark, that if you want to change anything in a multi actor environment, those actors have to cooperate and collaborate.

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Appendix A: Interview Reports

Appendix A1: Evaluation report of interview at Erasmus MC

Erasmus Medical Centre Logistics

Date: Friday 1st of August 2014
Time: 13:00pm-15:00pm
Location: Westzeedijk 361, 3015 AA Rotterdam
Attendees: Steven Wiekamp (Logistics manager Erasmus Medical Centre) and Vincent Oomen (researcher)

The Erasmus medical centre (Erasmus MC, 2014) is the largest hospital of the Netherlands, situated in the middle of Rotterdam. The size of this medical centre can be explained by both the location, in the centre of one of the largest cities in the Netherlands, and the amount of proceedings. The Erasmus MC provides not only cure, but it is also an educational and research facility.

In total 1300 beds are available in the Erasmus MC, but this will be brought down to 1000 in the future. This provides work for approximately 13000 people, with 100 working in the logistics department. The logistics department is responsible for the mail, the central distributions centre in Barendrecht, the central distribution in the Erasmus MC and the internal transport. The logistics of the textiles and food are not the responsibility of the logistics department, but this is debatable in the future. A total of 80 FTE are used by the logistics department with a cost of 3.5 million euros for staff and 2.5 million for materials a year. With a total calculated losses per year of 22000 euros.

Of the freight transported by the logistics department, 60 % of the orders are made using the Oricale interface (order system used by Erasmus MC). The remaining 40 % is ordered separately and delivered by an external courier. The freight that is ordered using the Oricale interface is delivered from the central distribution warehouse in Barendrecht to the central distribution in the Erasmus MC, from where it is transported to the different wards and departments. All goods delivered in this fashion are tracked and traced to the different wards. The goods delivered from the central warehouse are for 40 % standard stock goods and for 60 % specifically ordered.

The Erasmus MC is leading the way in two logistic directions. The first is the order supply chain of Oricale. This provides a system that automatically process any order made in the order system. The system not only orders the product, but also handles all payments automatically without human interference. Secondly, for specific goods a connection is made between the logistics and the electronic patient system. This lets these goods be automatically ordered when used or when the stock of these goods is too low. And these goods can be tracked into the patient, which provide extra security. This is only done for

very expensive goods, because all the goods have to be separately unpacked and tracked, which tacks a lot of manpower.

Critical components

The Erasmus MC has two mayor critical components, the effects of "island politics" (all departments only focus on them self) and the small amount of standardisation. The problem of the "island politics" is the limited information sharing between the different departments. This makes it hard to optimize the logistics for the total facility, which creates unseen losses. An example of this, are the multiple side by side transportations throughout the facility.

Possible future

The Erasmus MC is, at the moment of writing this report, under major construction and renovation, which will be finished in the year 2017. The new design of the Erasmus MC takes into account both the logistic movements throughout the facility and growth of this department. A main logistics backbone has been constructed under the facility to transport the freight. This passageway is large enough to handle possible AGV's (automated guided vehicles) to be used to handle the internal transport. Another development will be the improvement of connecting the freight logistics to the electronic patient system, which is at this moment only used for specific goods.

Appendix A2: Evaluation report of interview at Maasstad Hospital

Maasstad Hospital

Date: Friday 8 of August 2014
Time: 09:30pm-11:00pm
Location: Maasstadweg 21, 3079 DZ Rotterdam
Attendees: Arjan Kegel (Logistics manager Maasstad Hospital) and Vincent Oomen (researcher)

The Maasstad hospital (Maasstad Ziekenhuis, 2015) is a midsize hospital situated in the south of Rotterdam. The Maasstad hospital has been created from a consortium of the Sint Clara hospital and Zuiderziekenhuis. The hospital was finished 4 years ago, and in this new building a logistic backbone through the basement was constructed.

The Maasstad hospital has 600 beds, which provides work for around 3200 people. With around 50 employees work at the logistics department and provide 47.5 FTE of labour. This logistics department is responsible for, the waste disposal, goods deliveries, cleaning and stocking of de-central stocks, the central warehouse in Barendrecht, Central Sterile Supply Department, making the operating room trace ready, pharmacy supply deliveries and mail. The budget for the logistics department is 3.5 million euros a year, with 10000 euros of predicted losses.

The goods delivered to the Maasstad hospital are for 95% ordered by the VILA system (order system of Maasstad) or the web portal. These goods are distributed from the central warehouse in Barendrecht. In this warehouse, only 8% of the stock goods are located, the other 92% have to be ordered when needed. The goods delivered to the operation theatre are already unpacked and prepared in the central distribution centre, so that an operation can be performed using only the goods from the carts. These fully prepared supply carts take more manpower to prepare, but logistic manpower is cheaper than health care specialist's manpower.

In the last couple of years the logistics department was improved and professionalised. This was possible because of the new building, which takes the logistics department into account in the design, and because of better communications with the different departments. All departments have a single logistics staff member as a direct contact. This improved the power and respect of the logistics department within the hospital.

The improvements in the logistics department can be divided into two main directions. Firstly, most goods have been standardised throughout the hospital. And secondly, deliveries and stocks are optimized by communicating with all different departments.

Critical components

There are still critical parts within the freight logistics of the Maasstad hospital. These problems can be divided into two main perspectives. Firstly, both purchasing and purchasing registration have to collaborate more efficient. And secondly, the new building provides multiple limitations. The largest limitation, are the two elevators, in the incoming goods

station, where all 80 carts have to be processed through from the morning delivery. Another possible opportunity would be further improvements in the communication, on the logistics, between the different departments and wards within the hospital.

Possible future

In the future a new electronic system will be implemented in the Maasstad hospital, the ERP (Enterprise Resource Planning). This system makes it possible for the system to be more autonomic and automatically orders goods when there is observed that the stock is too low. It also makes it possible to connect freight needs to a patient or operation. This makes it possible to improve optimization of logistics and stock.

Advise

Arjan Kegel has two main advices. Firstly, there should be more collaboration in the logistics with other facilities and organisations. This could reduce material and building costs. But if also the logistic staff is shared between organisations, that could also reduce employment costs and quality degradation. And secondly, a better prediction of the needed logistics has to be made clearer to all parties involved throughout the supply chain.

Appendix A3: Evaluation report of interview at Rivas and Logiz

Rivas and Logiz

Date: Monday 18 of August 2014
Time: 10:30-12:00
Location: Banneweg 57, 4204 AA Gorinchem
Attendees: Pieter Vlot (Hoofd Logistieke Services), Jan Scheffer (Logiz) and Vincent Oomen (researcher)

Rivas

Rivas (Rivas, 2014) is a cure and care organisation with a service area situated south of Utrecht and between the Randstad and North Brabant. Within Rivas, all types of both care and cure are provided. This makes Rivas similar to the total health care system in the Netherlands, but smaller in size.

The Cure facility of Rivas has 323 beds, but the total organisation of Rivas provides work for 6000 people. Of these 6000 staff, 30 work in the logistics department. This department provides 30 FTE's of labour and is responsible for the waste disposal, residual flows, goods deliveries, stocking of de-central stocks and deliveries and mail. The central warehouse and external flows to the organisation are provided by hospital logistics.

The goods delivered to the Rivas are for 95% ordered by the Orical system (order system of Rivas and Hospital Logistics) or the web portal. If goods are ordered, these goods can be delivered directly from the warehouse, or have to be ordered from the supply. If the order can be delivered directly from the warehouse it takes only a day from ordering to delivery. If this is not the case, the delivery time is 2 weeks maximum. These goods are distributed by Hospital Logistics to the central cure facility of Rivas, from which the goods are delivered to all other facilities and departments, both internal and external. These deliveries from the cure facility of Rivas are all done by the logistics departments of Rivas. This will be changing, because Rivas is at the moment of writing this report, transferring to another logistics provider. Rivas will quit using Hospital Logistics and has chosen for King.

King will provide not only central warehouse management and logistics, but also purchasing of goods and the logistics to the different facilities of Rivas. This has to reduce the amount of needed transportation and the carbon output. The new construction between Rivas and King has to make the logistics economical, by improving the transparencies between the different parties within the goods supply chain. This is done without needing extra or new investments in the supply chain.

Logiz

Logiz is a non-profit organisation that tries to inform and educate the health care system on the needs and importance of logistics. It consists of 3 people and 3 staff members. Logiz was working together with Rivas to provide an external view on the new contract of King and the previous contract of Hospital Logistics.

Advice

The advice given by both Pieter Vlot from Rivas and Jan Scheffer of Logiz, is that the health care system should improve the logistics by focusing on supply chain improvements and to stop looking at every part separately. This can only be done by transparency and collaboration throughout the supply chain.

Appendix A4: Evaluation report of interview at Orbis

Orbis Medical Centre Logistics

Date: Monday 28th of July 2014
Time: 11:00pm-12:30pm
Location: Dr. H. van der Hoffplein 1, 6162 BG Sittard-Geleen
Attendees: Hugo de Loo (Logistics manager Orbis Medical Centre) and Vincent Oomen (researcher)

Orbis is one of the larger health care organisations in South and Central Limburg which provide cure, care, at home care and all other facets of health care. Orbis is in collaboration with Atrium and AZM. This collaboration increases their collectively purchase power and decrease costs.
The Orbis Medical Centre, part of Orbis, is no ordinary hospital. The facility is focused on providing a positive and homey feeling on any visit. This vision was conceived with the construction of the new facility, which was finessed in 2009 (Orbis). This facility uses brand new technologies for the internal transport, like the use of transport robots. The implementation of these technologies was possible because of the design of the new facility was constructed around the implementation of these technologies. These technologies mean that the work load of the logistics division of the Orbis Medical Centre is very low, only 16 FTE.

Figure 30 Transport robots in Orbis (iseco)

The general freight logistics of Orbis is focused around the collaboration with Hospital Logistics. Hospital Logistics provides all freight order by SAP (freight ordering system used by Orbis) to Orbis in already fully prepared trolleys per department. These trolleys are transported internally with the use of robots, out of view of the patients. The collaboration with Hospital Logistics means that orbis has no central warehouse, only de-central storage per department. In these de-central storage a two pick system is in use. A two pick system means that for all products a minimum of two packages are available and if the first is empty the second is used and a new one is ordered. These orders are delivered twice a day and ordered using the SAP system.

Critical components

The logistic department has found three main critical components in the past two years, which are being improved if possible.

The first critical parts are the physical limitations of the facility, the elevators. Elevators are the bottlenecks within the hospital, which limit both the amount and frequency of internal transport.

The second critical parts are the orders and order system of Orbis. Only approximately 50% of the orders are made using the SAP system of Orbis the other 50% are ordered separately and are not delivered by Hospital Logistics but by a separate courier. The orders made in SAP can also be divided into two groups: Stock orders, orders that are made of empty stock in the two pick system, and non-stock orders. The NON-SAP orders are very hard to organise and, similar to the non-stock orders, hard to optimize. Hugo de Loo is focussing to decrease the percentage of both the Non-Stock and NON-SAP orders placed. This is done by increasing the amount of different stock goods and by better communicating the advantages of using SAP to the different departments.

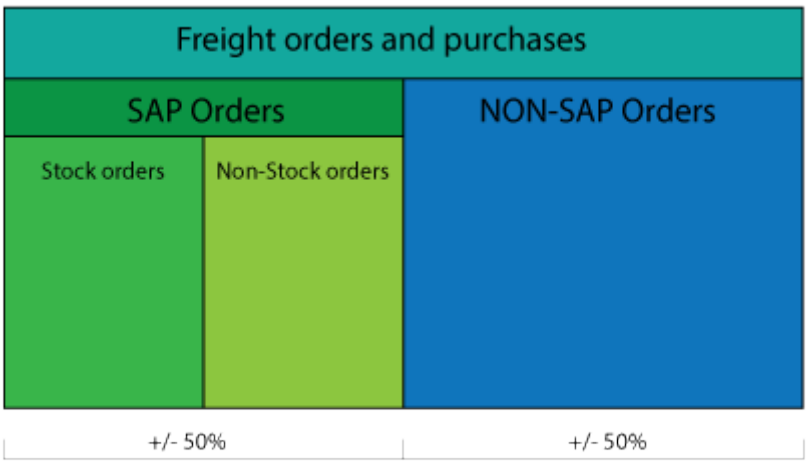


Figure 31 Type of orders placed in Orbis

The third and last critical part for the logistics department is the communication and professionalism of the other departments. Not all communication is clear and without faults and not all rules are being followed. This is solved by focussing on the problem areas and not solving only the effects of the problems and by implementing the rules more harshly.

Advise

The main advice from Hugo de Loo for the freight logistics in the health care is to stop looking at every part separately and focus on supply chain improvements. To translate Hugo de Loo directly: "*Think in supply chains.*"

Appendix A5: Evaluation report of interview at Albert Schweitzer Ziekenhuis

Albert Schweitzer Hospital

Date: Tuesday 26 of August 2014
Time: 10:00pm-12:00pm
Location: Albert Schweitzerplaats 25, 3318 AT Dordrecht
Attendees: Henk Damen(Logistics manager ASZ), Mustafa Karraz (Logistics manager of environment and shaping) and Vincent Oomen (researcher)

The Albert Schweitzer Hospital (ASZ) is a midsize hospital located in Dordrecht. The ASZ has multiple facilities, all located in and around the city of Dordrecht. This hospital is on paper the best hospital of the Netherlands.

The ASZ has a total of 700/800 beds, this will reduced in the future to 450/500. At the current situations, this provides work for 2661 people. With around 60 employees work at the logistics department and provide 47 FTE of labour. This logistics department is responsible for, the waste disposal, goods deliveries, the central warehouse, Central Sterile Supply Department, linen and cloths, blood transportation, pharmacy supply deliveries and mail.

The goods delivered to the ASZ are for 80% ordered by the SAP system (order system of ASZ) and web portal. Of the remaining 20% of goods delivered, 18% is ordered by scanning of the de-central storage and 2% is ordered to third parties. The scanning of these de-central storage is done 1 or 2 times a week, depending on the type of department for which this de-central storage serves. The goods that are ordered are delivered in the different departments within 48 hours of ordering. The goods are delivered to the central warehouse that is closely situated (within 5 minutes of driving distance) of the central facility of the ASZ. 500 deliveries are made to the central warehouse daily. A part of these goods are for storage and part is directly cross docked for delivery to the different facilities. At this moment 50% of the goods are delivered to the facilities using cross docking, this will be improved to 80% in the near future.

Every day 30 to 35 carts are delivered from the central warehouse to the logistics department. Of these carts, 15 are from the CSA. Next to the carts delivered, also 7 to 10 pallets of goods are delivered to the logistics department daily. The logistics department handles the goods from delivery to the facility up till the delivery to the different departments. The goods delivered by the logistics departments are tracked and traced using the available barcodes on the product from the moment the goods are in procession of ASZ. Some specific goods are even connected to the electronic patient file, so that these goods can even be tracked into the patient. This is only done for specific goods with a high monetary value and that stay in a patient for a long time.

Critical components

There are still critical parts within the good logistics of the ASZ. These problems can be divided into three main issues. Firstly, the changes and reconstruction in and around the different departments and facilities are not communicated with the logistics department. This means that the logistics staff sometimes has to improvise to provide the agreed services. And secondly, the building provides multiple limitations. The largest limitation, are the elevators in the facility. These elevators are used for both patients and goods transportation, which can create bottlenecks. The last issue is that ICT systems are not compatible or cannot easily communicate.

Advise

ASZ has two main advices for the goods logistics. Firstly, improve the collaboration between the suppliers and health cure/care organisations to reduce and optimize the size of the supply chain. And secondly, if you want to change a thing within the different facilities or departments, "make these actors feel it in their pockets". Provide a cost for the actors involved for not joining the change.

Appendix A6: Evaluation report of interviews concerning decision health care pathways

Health care pathways decision

Date: Friday 17th of October 2014
Time: 10:00pm-10:45pm
Location: Van Vollenhovenstraat 6, Rotterdam
Attendees: L. van Donkelaar and Vincent Oomen (researcher)

Date: Wednesday 12th of November 2014
Time: 15:30pm-16:30pm
Location: Maasstadweg 21, 3079 DZ Rotterdam
Attendees: E. Giesselbach and Vincent Oomen (researcher)

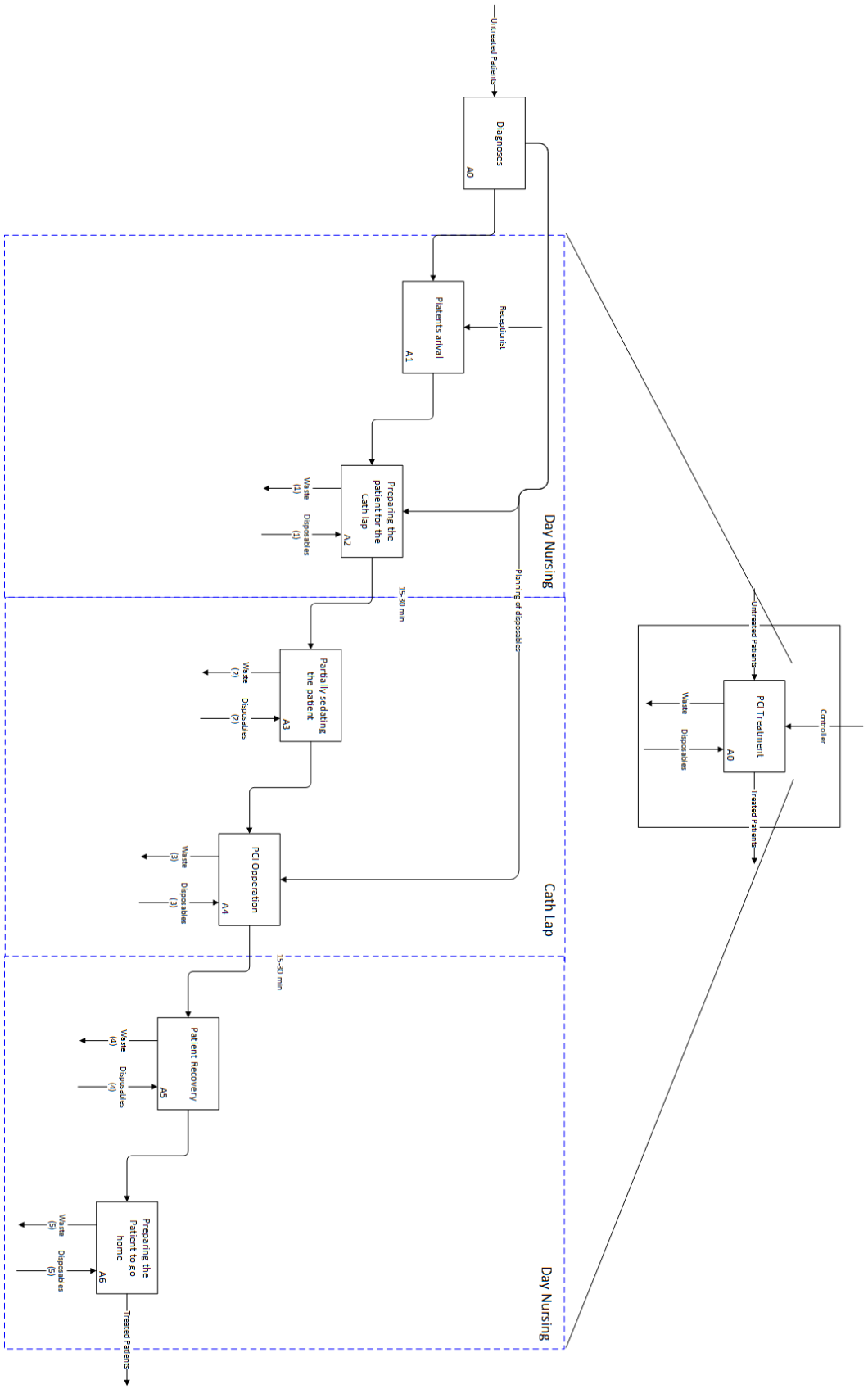
To provide a base for the decision on which health care pathways to research, two interviews has been conducted with specialists in the field. The first of the two interviews was with Mrs. L. van Donkelaar of the Erasmus MC. In this interview the basic principles and ideas of this researched were discussed. The main idea was to research the amount of wasted disposables in multiple different health care pathways. At the moment of this interview no criteria's were determinate on which criteria's these health care pathways should possess. Within the interview five different health care pathways emerged to be relevant for this report. These health care pathways have a relative high flow of patients and these patients move relatively fast throughout this health care pathway. The pathways that are relevant, when based on the criteria's, are:

- Chest pains with the treatment Percutaneous Coronary Intervention (PCI)
- Cataract
- Hip fractures
- Cerebral Vascular Accident (CVA)
- Appendicitis

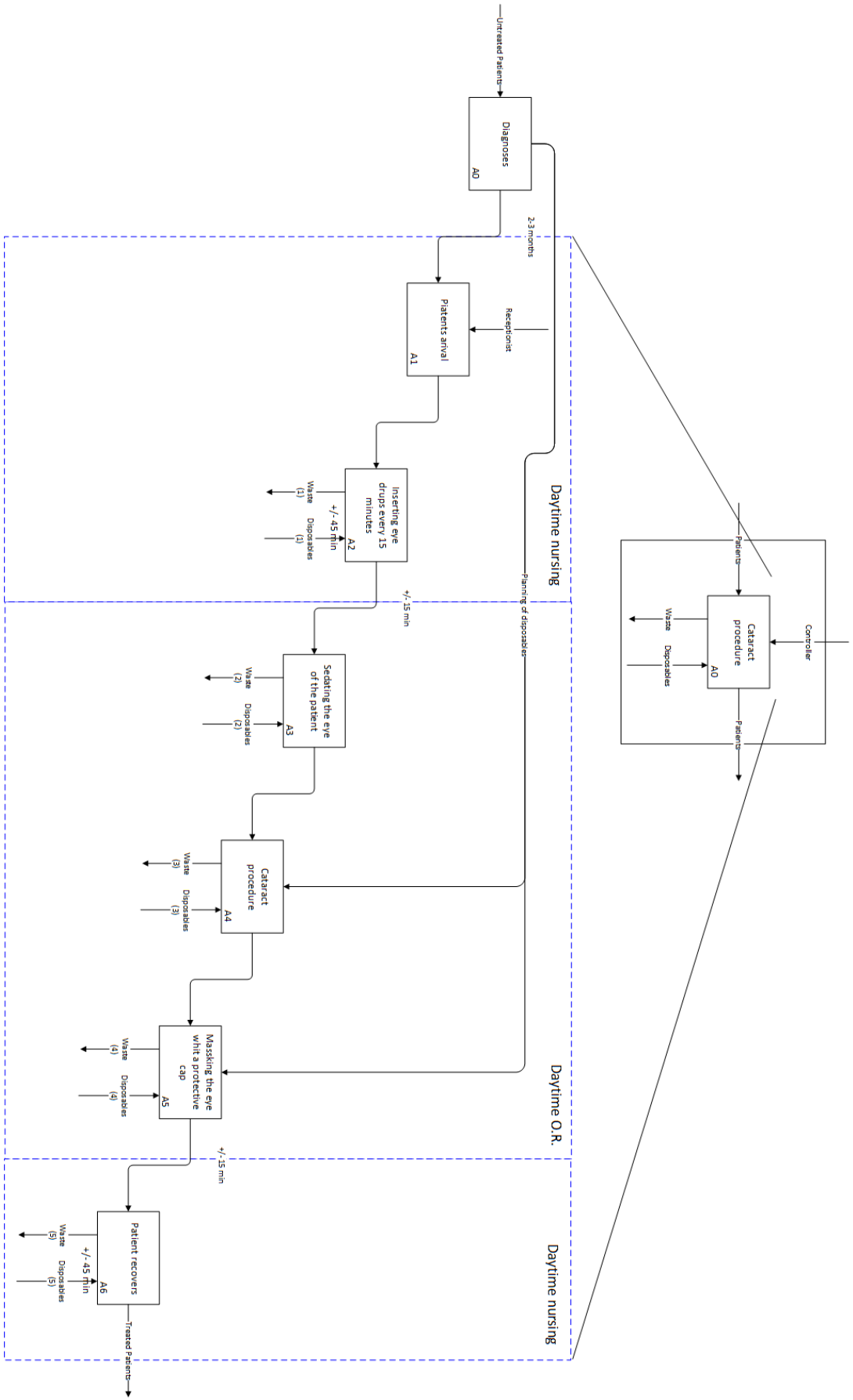
In the second interview, with Mrs. E. Giesselbach of the Maasstad hospital, these relevant health care pathways where discussed. Mrs. E. Giesselbach started with explaining that these treatments are not called health care pathways within her organisation, but DBC's (diagnosis treatment combination). These five DBC's where, in her professional opinion, not all optimal for the direction of this research. The DBC of Appendicitis is less of a health care pathway and more of a highly standardized and established treatment with no differentiation between different hospitals. The other four health care pathways where relevant for this research.

Appendix B: IDEF0 Diagrams

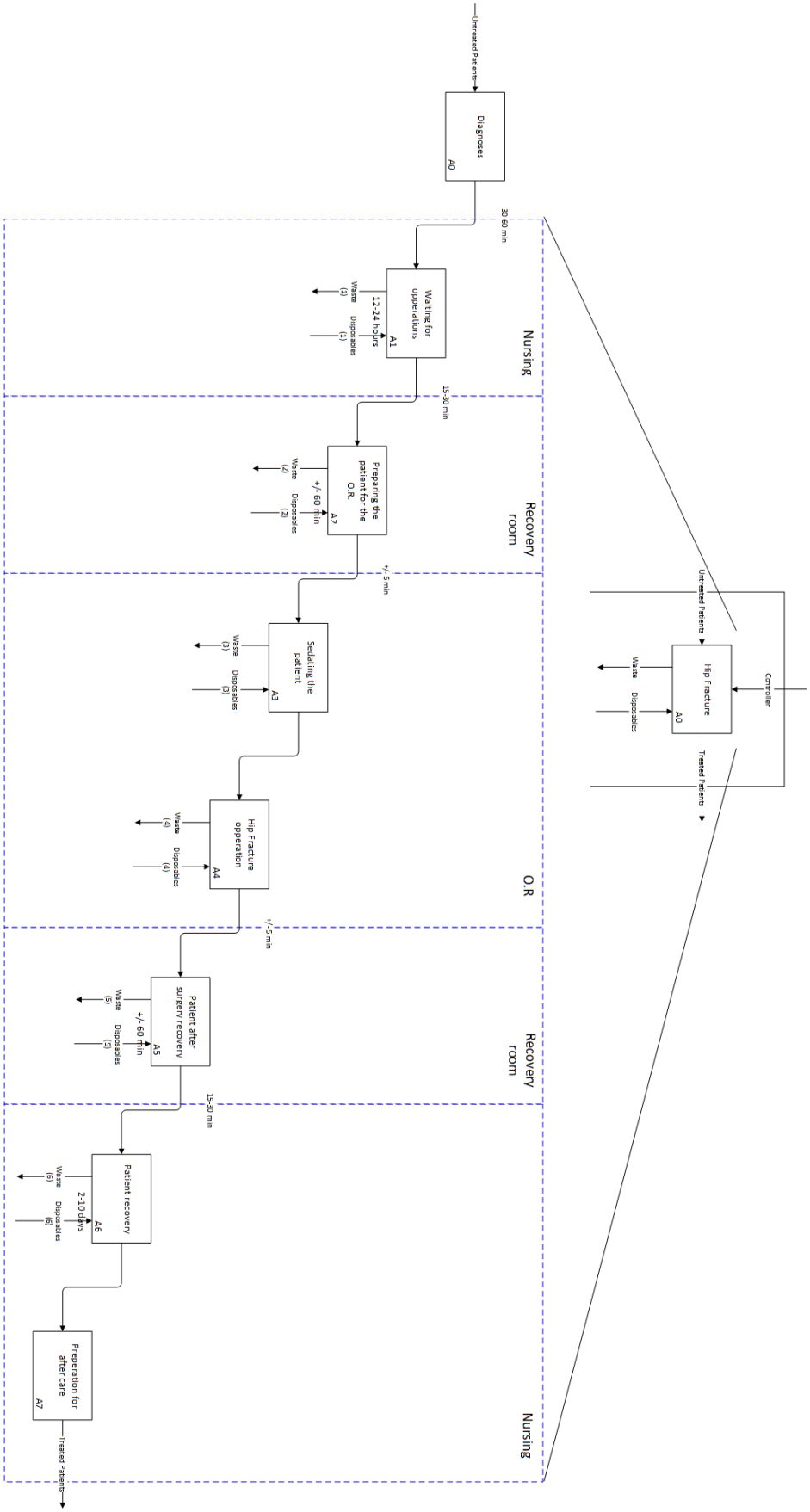
Appendix B1: PCI IDEF0



Appendix B2: Cataract IDEF0



Appendix B3: Hip Fracture IDEF0



Appendix C: DBC list Cataract, PCI and hip fractures

Table of the DBC codes for the researched health care pathways of Cataract, PCI and hip fractures (in Dutch).

Table 19 DBC List

	Cataract
70401002	GEEN Uitval standaard, Intensieve/ invasieve therapie, Complexe cataractoperatie
70401008	GEEN Uitval standaard, Intensieve/ invasieve therapie, GEEN Complexe cataractoperatie, Standaard cataract operatie, GEEN Met VPLD
70401009	GEEN Uitval standaard, Intensieve/ invasieve therapie, GEEN Complexe cataractoperatie, Standaard cataract operatie, Met VPLD
	PCI
219699018	GEEN Uitval standaard, Cardiologie, GEEN Follow-up na acuut coronair syndroom, Follow-up na hartoperatie/ PCI/ ablatie, GEEN Dag/ Klin cumulatief, GEEN Ambulant middel, GEEN Licht ambulant
219699019	GEEN Uitval standaard, Cardiologie, GEEN Follow-up na acuut coronair syndroom, Follow-up na hartoperatie/ PCI/ ablatie, GEEN Dag/ Klin cumulatief, GEEN Ambulant middel, Licht ambulant
219699020	GEEN Uitval standaard, Cardiologie, GEEN Follow-up na acuut coronair syndroom, Follow-up na hartoperatie/ PCI/ ablatie, Dag/ Klin cumulatief, GEEN Dag/ Klin cumulatief kort, GEEN Dag/ Klin cumulatief middel
219699021	GEEN Uitval standaard, Cardiologie, GEEN Follow-up na acuut coronair syndroom, Follow-up na hartoperatie/ PCI/ ablatie, Dag/ Klin cumulatief, GEEN Dag/ Klin cumulatief kort, Dag/ Klin cumulatief middel
	Hip Fractuur
199299009	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, Implantatie kop-hals prothese lang (periprothese fractuur)
199299014	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, Diagnostisch (zwaar)/ Therapeutisch licht
199299014	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, Diagnostisch (zwaar)/ Therapeutisch licht
199299015	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, Klinische opname, Klin kort
199299015	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, GEEN Intensieve/ invasieve therapie, Klinische opname, Klin kort
199299022	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, Dag/ Poli >2/ Routine onderzoek >2
199299022	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, Dag/ Poli >2/ Routine onderzoek >2
199299023	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, Klinische opname, GEEN Klin kort, GEEN Klin middel
199299023	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, GEEN Intensieve/ invasieve therapie, Klinische opname, GEEN Klin kort, GEEN Klin middel
199299024	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, Klinische opname, GEEN Klin kort, Klin middel
199299024	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, GEEN Intensieve/ invasieve therapie, Klinische opname, GEEN Klin kort, Klin middel
199299025	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), Implantatie totale heupprothese, GEEN Met VPLD
199299025	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), Implantatie totale heupprothese, GEEN Met VPLD
199299026	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), Implantatie totale heupprothese, Met VPLD
199299026	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), Implantatie totale heupprothese, Met VPLD
199299034	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, GEEN Dag/ Poli >2/ Routine onderzoek >2, GEEN Licht ambulant
199299034	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, GEEN Dag/ Poli >2/ Routine onderzoek >2, GEEN Licht ambulant II
199299034	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, GEEN Dag/ Poli >2/ Routine onderzoek >2, GEEN Licht ambulant

199299035	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, GEEN Dag/ Poli >2/ Routine onderzoek >2, Licht ambulant
199299035	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, GEEN Dag/ Poli >2/ Routine onderzoek >2, Licht ambulant II
199299035	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, GEEN Intensieve/ invasieve therapie, GEEN Klinische opname, GEEN Diagnostisch (zwaar)/ Therapeutisch licht, GEEN Dag/ Poli >2/ Routine onderzoek >2, Licht ambulant
199299036	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, GEEN Implantatie kop-halsprothese kort, GEEN Oper heup/ bekken intra-articulair
199299036	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, GEEN Implantatie kop-halsprothese kort, GEEN Oper heup/ bekken intra-articulair
199299037	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, Implantatie kop-halsprothese kort, GEEN Met VPLD
199299037	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, Implantatie kop-halsprothese kort, GEEN Met VPLD
199299038	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, Implantatie kop-halsprothese kort, Met VPLD
199299038	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, Implantatie kop-halsprothese kort, Met VPLD
199299043	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, GEEN Implantatie kop-halsprothese kort, Oper heup/ bekken intra-articulair, GEEN Met VPLD
199299043	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, GEEN Implantatie kop-halsprothese kort, Oper heup/ bekken intra-articulair, GEEN Met VPLD
199299044	GEEN Uitval standaard, GEEN Beschouwende specialismen, GEEN Multitrauma ISS >= 16, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, GEEN Implantatie kop-halsprothese kort, Oper heup/ bekken intra-articulair, Met VPLD
199299044	GEEN Uitval standaard, GEEN Beschouwende specialismen, Heupfractuur, Intensieve/ invasieve therapie, GEEN Implantatie kop-hals prothese lang (periprothese fractuur), GEEN Implantatie totale heupprothese, GEEN Implantatie kop-halsprothese kort, Oper heup/ bekken intra-articulair, Met VPLD

Appendix D: List of interviewed persons, researched facilities and health care pathways

Within this research multiple persons and organisations where met and helped with the research. This appendix will list all persons interviewed, in which organisation and in which health care pathway. Another list will be provided that shows the different departments that where visited during the field research.

Table 20 Interviewed persons list

Interviewed persons list		
Person	**Health care pathway**	**Health care organisation**
Mr. S.J.F.M. van Gisbergen	Percutaneous Coronary Intervention	Erasmus Mc
Mr. D.J.C. de Haas	Percutaneous Coronary Intervention	Erasmus Mc
Mrs. K Vissers	Cataract	Maasstad Ziekenhuis
Mr. R.A.H. Vogel	Hip fracture	Maasstad Ziekenhuis
Mrs. P. Boel	Hip fracture	Beatrixziekenhuis Rivas

Table 21 Field research list

Field research list		
Department	**Health care pathway**	**Health care organisation**
Care department	Percutaneous Coronary Intervention	Erasmus Mc
Cath Lab	Percutaneous Coronary Intervention	Erasmus Mc
O.R.	Cataract	Maasstad Ziekenhuis
Care department	Hip fracture	Beatrixziekenhuis Rivas
Logistics at O.R.		Beatrixziekenhuis Rivas

Appendix E: Interview reports of researched health care pathways

Appendix E1: Evaluation report of interview PCI at Erasmus MC

Erasmus Medical Centre thorax department

Date: Monday 10th of November 2014
Time: 9:00AM-10:00AM
Location: Westzeedijk 361, 3015 AA Rotterdam
Attendees: S.J.F.M van Gsibergen (Team leader Interventional Cardiology Department)and Vincent Oomen (researcher)

The Thorax department treats an average of 1000 PCI patients yearly. With another 500 PCI patients going directly through the intensive care and not going to the Thorax department. A large part of the patients that are treated for PCI come from other hospitals, these patients are dropt of in the morning and picked up after the procedure. A patient will travel through this health care pathway within 4 to 6 hours. This is a big improvement on the 72 hours that it took a couple of years ago. After coming in, the patient starts at the care department. At this department that patient is prepared for the procedure. The preparation varies depending if the procedure is done via the groin or the wrist. The standard procedure, around 60/70%, is done via the wrist and only in special occasions it is done via the groin, when it is an emergency or if via the wrist is not possible. When the procedure is done via the groin the patient's groin is shaved before the operation. After the preparations, the patient will move to the Cath Lab where the PCI procedure will take place. After the procedure the patient will move back to the care department to recover.

The Erasmus MC is an academic hospital were mostly specialist operations are conducted. Most PCI procedures in general hospitals involve 2 stents while in the Erasmus MC an average of 6 to 8 stents are needed.

After the interview a pamphlet was provided that provided an overview of the health care pathway PCI in the Erasmus MC (Erasmus MC, 2012).

Waste

No direct waste is found in this health care pathway, the only predicted waste is meals that have to be thrown away.

Appendix E2: Evaluation report of interview PCI at Erasmus MC

Erasmus Medical Cath lab department

Date: Monday 11th of December 2014
Time: 11:00AM-11:45AM
Location: Westzeedijk 361, 3015 AA Rotterdam
Attendees: D.J.C. de Haas and Vincent Oomen (researcher)

The PCI procedures are all conducted in the Cath Lap of the thorax centre. In these procedure multiple disposables are used. The disposables that are used and their costs are:

Angiotray/pakket (gazen,hoezen,naalden,stickers bakjes etc)	185,38 incl. btw
Sheath femoraal/radiaal	6,31 incl. btw (femoraal) 26,00 incl. btw (radialis)
TR Band (afsluiter na radialis)	12,00 incl. btw
Wire (opvoeren en weg vinden naar te stenten deel)	71,55 incl. btw
Drug Eluting Stent/Absorbable scaffold (oplosbare stent)	636,00 incl. btw (DES)
Guiding catheter	47,70 incl. btw
Angioseal (afsluiting lies)	114,48 incl. btw
Absorb scaffold	1219,00 incl. btw
(de absorbable scaffold is sinds kort een 2e stent type dat in gebruik is. Als deze 1 of 2 x in patient gaat is de kostenpost per PCI soort weer anders uiteraard).	
Total: **incl. btw**	**1061,42**

Waste

Of these disposables a total of 60000 euros are lost in the last three combined years. This implies that around 20000 euros are wasted yearly, around 0.5 FTE.

Appendix E3: Evaluation report of interview Cataract at Maasstad Hospital

Maasstad Hospital

Date: Friday 9th of January 2015
Time: 13:00pm-13:45pm
Location: Maasstadweg 21, 3079 DZ Rotterdam
Attendees: K.I.M. Vissers -de Moor (Manager Maasstad Hospital) and Vincent Oomen (researcher)

The Maasstad hospital has around 2500 patients that travel through this health care pathway. These patients travel through this health care pathway in around 2 hours. This health care pathway starts in the day care department. In this department the patient is prepared for the procedure. During this preparations the patients eye will be dripped 4 times, ones every 15 minutes. After this preparation, the patient will be moved to the operation room where the procedure takes place. This procedure takes around 30 minutes to complete. All disposables that are used during this procedure are included in a standardized disposable kit. The only exceptions are new eye lens and the medical gloves and facemask. After the operation, the patient will be moved back to the day care department. There the patient will recover for around 45 minutes before he or she can go back home. The patient can return to the hospital in approximately 6 week for the second eye.

Waste

This health care pathway is short and standardized, which limits the amount of disposables needed and wasted. In the day care department the disposables are stored in a two bin system and in the operation room all disposables are in disposables kits that are standardized and stored on a cart. The disposable kits stored on theses carts are for the specific operations of that day, so no extra disposables are stored. The exceptions are the eye lenses, but any eye lens that reaches the expiration date can be returned to the supplier and replaced free of charge.

Appendix E4: Evaluation report of interview hip fractures at Maasstad Hospital

Maasstad Hospital

Date: Wednesday 17 of December 2014
Time: 13:00pm-13:45pm
Location: Maasstadweg 21, 3079 DZ Rotterdam
Attendees: R. Vogel(Manager chirurgie & brandwondencentrum Maasstad Hospital) and Vincent Oomen (researcher)

The Maasstad hospital has around 450 patients that travel through this health care pathway. Most of the patients come from the emergency room. After the diagnostics determined, the patient will be transported to a care department where the patient is prepared for the operation. The patient will be operated on within 24 hours after arriving in the care department. Just before and after the patient is operated, the patient is situated in the recovery room. Before the operation, the patient will provide a conformation on which hip to operate in this recovery room. And after the operation the patient will return to the recovery room to recover from the operation, for around a hour, before going back to the care department to further recover. After around 2 to 20 days the patient will be discharged and leave the hospital. The time the patient will stay within the care department is determined by the age of the patient, severance of the operation, the recovery speed of the patient and the potential after care outside of the hospital.

Waste

The hospital works with a two bin system to reduce the possibility of disposables expiring. And the amount of disposables that have to be stocked is limited, because of the plannability of most steps within this health care pathway. This plannability comes from the time that the patient has to wait in the care department before going to the operation and the small amount of disposables needed during this waiting time. The disposables needed in this health care pathway have mostly long shelf lives and do not expire often.

Appendix E5: Evaluation report of interview hip fractures at Rivas

Rivas

Date: Tuesday 23 of December 2014
Time: 11:30-12:15
Location: Banneweg 57, 4204 AA Gorinchem
Attendees: P Boel (Manager Rivas) and Vincent Oomen (researcher)

The Beatrix hospital of the health care organisation Rivas has around 100 patients that travel through this health care pathway. Most of the patients come from the emergency room. After the diagnostics determined, the patient will be transported to a care department where the patient is prepared for the operation. The patient will be operated on within 24 hours after arriving in the care department. Just before and after the patient is operated, the patient is situated in the recovery room. Before the operation, the patient will provide a conformation on which hip to operate in this recovery room. And after the operation the patient will return to the recovery room to recover from the operation, for around a hour, before going back to the care department to further recover. After around 2 to 20 days the patient will be discharged and leave the hospital. The time the patient will stay within the care department is determined by the age of the patient, severance of the operation, the recovery speed of the patient and the potential after care outside of the hospital.

Waste

The hospital works with a min max system to reduce the possibility of disposables expiring, if handled correctly. And the amount of disposables that have to be stocked is limited, because of the plannability of most steps within this health care pathway. This plannability comes from the time that the patient has to wait in the care department before going to the operation and the small amount of disposables needed during this waiting time. The disposables needed in this health care pathway have mostly long shelf lives and do not expire often.