Process-alignment in focused factories; an international comparison between eye hospitals, focused on the cataract process.

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They Focus, we Focus

Eye Focus!

Research within the framework of a master's project,

in order to complete the study 'Industrial Engineering & Management' at the School of Management and Governance, University of Twente, the Netherlands.

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Management summary

The University of Twente and Maastricht University started a project in 2005 to support research about focused factories in hospital care. This research elaborates on the gathered experiences and results of two previous studies and contributes to the knowledge of focused factories in hospital care, aimed at the design of the care delivery system; the process-alignment. A focused factory is defined as: 'An organization or (autonomous) organizational unit which care-delivery system is directed towards a well-defined and limited group of patients and/or a limited range of services offered, with a high degree of process-alignment (Bredenhoff et al., 2007). Three international good practice eye hospitals are compared to gain insights into the design, the efficiency and the operational effectiveness of the care delivery systems:

- The Rotterdam Eye Hospital, Rotterdam, The Netherlands
- Moorfields Eye Hospital, London, The United Kingdom
- The New York Eye and Ear Infirmary, New York, The United States if America

This research focused on the cataract process, defined as: 'The successive sub-processes a cataract patient go through in order to cure the cataract, starting with the first out-patient consultation in the eye hospital and ending after the first review after surgery'. Cataract is a clouding of the lens that causes vision to become hazy and eventually cause blindness in the affected eye (Marieb, 2000). The objective of the research is:

'To study the ***association*** between process-alignment, efficiency and operational effectiveness of care delivery systems in focused factories by analyzing and comparing the cataract processes of three international good practice hospitals'

Operational effectiveness is examined as: 'The degree to which the cataract process reduces waiting times and potentially harmful delays for both those who receive and those who give care'. ***Efficiency*** is defined as: 'The degree to which the process avoids waste and minimizes the amount of resources used in delivering care'. ***Process-alignment*** is interpreted as: 'The extent to which the sub-processes of a care delivery system fit to each other, and fit to the chosen type of focus, regarding the served patients and offered services. In order to smoothen the patient's flow through the process, to reduce waste and to reduce waiting times for as well patients as professionals. By preventing interruptions from other processes and synchronizing the executed primary and supporting procedures, operational planning systems, capacities and resources in the field of personnel, medical Technology and knowledge'

The hospitals are compared by means of a framework that was formulated after studying the literature and the cataract process in The Rotterdam Eye Hospital. The goals of applying the framework were:

- To gain insights into the efficiency and the operational effectiveness of the cataract process.
- To gain insights into the process-alignment of the cataract process.
- To investigate the association between process-alignment, efficiency, and operational effectiveness of the cataract process.

The framework includes 15 hypotheses that are formulated to measure and describe the process-alignment. 4 indicators are formulated to measure the operational effectiveness and efficiency of the cataract process.

A main hypothesis was formulated to propose a possible association between process-alignment, operational effectiveness and efficiency:

'A higher extent of process-alignment is ***positively associated*** with increased efficiency and operational effectiveness of the cataract process'

Positive association is demonstrated for two variables when above-average values of one tend to accompany above-average values of the other and below-average values also tend to occur together (Introduction to the practice of statistics, 2005). 10 hypothesis are considered as appropriate tools to measure the extent of process-alignment of the cataract process. 3 hypotheses are suspected to be positively associated with efficiency and 1 hypothesis is suspected to be positively associated with operational effectiveness. Recommendations are proposed for the hospitals to improve their process-alignment, based on the positively associated hypotheses.

Concluded is that this research demonstrated positive association between the extent of process-alignment and the efficiency of the cataract process. Furthermore, positive association is suspected between the extent of process-alignment and the operational effectiveness of the cataract process. The main hypothesis is accepted.

Further research is recommended to examine the process performance of Cataract Clinics like Moorfields Cataract Clinic in comparison with other focused factories. One should focus on the advantages and disadvantages of the usage of dedicated resources and if this dedication has a positive effect upon the efficiency and/or operational effectiveness. If the answer is positive, it could be interesting to find out for how many treatments per year the establishment of a fully dedicated clinic generates the intended positive effects upon the efficiency and/or operational effectiveness.

Preface

This report is the result of the research executed to conclude the master 'Industrial Engineering and Management' at the school of Management and Governance, University of Twente. The process design of the cataract process is carefully examined at three international good practice eye hospitals to gain more insights into the process-alignment concept.

They focus, we focus, eye focus!

They, the companies in the manufacturing industry started to focus on a narrow product mix for particular market niches around 1970 and outperformed the conventional plants that attempted a broader mission.
We**,** the health care sector introduced focused factories in 1997.
'Eye' focused my research on the association between process-alignment, efficiency and operational effectiveness in eye hospitals to contribute to the knowledge of focused factories in hospital care.

Hereby, I would like to thank my supervisors of the University of Twente, professor van Harten, and Eelco Bredenhoff for offering me the opportunity to execute my research in combination with an unforgettable international experience. I would like to thank Ellen van Vliet who has been of great help during the whole duration of the project. Last, but not least, I would like to thank The Rotterdam Eye Hospital, Moorfields Eye Hospital and The New York Eye and Ear Infirmary for their support during the case studies. Ian Johnsson and Carmel King for their support in London. Sonja Tenarro, Editha Esquieres, Marianna Gorbethy and Lydia DeGracia Abrogar for making me feel at home in New York.

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1. Introduction

The University of Twente and Maastricht University started a project in 2005 to support research about focused factories in hospital care. In ***the first year***, three ambulatory chemotherapy departments of international comprehensive cancer centers were compared. This resulted in a classification of focused organizations based on their focus on patient groups and their focus on offered services (van Lent, 2006). In ***the second year,*** the University of Twente continued with a research that emphasized the relationship between focused factories and the efficiency of health care processes. Obtained results were that focusing on patient-categories is more efficient for inpatient care, the diagnosing process and the number of outpatient clinic return visits, but less efficient for day-care and for overhead and support (Admiraal, 2007).

This research is a continuation of the first and second year projects. It investigates if there is an relation between the efficiency and process-alignment of care delivery systems in hospital care. Three centers focused on eye surgery are compared. Related to this project, an operations research oriented project is foreseen, in which the same eye hospitals are involved in a simulation study. This simulation study aims to show the potential gains and best values of implementing several focus and alignment decisions.

This thesis is structured as follows. ***Chapter two*** explores the topic of the research by discussing the background, the relevance, the objective, the research questions and the research approach of the project. ***Chapter three*** presents the theory behind the 'Focused Factory' concept in manufacturing and in health care and elaborates on our interpretation of process-alignment. We provide the information to get a better understanding of the previous researches in the field, used definitions and the environment in which our research takes place. In c***hapter four,*** we describe the development of our framework for analyzing and comparing cataract processes. We use this framework to analyze and compare the process-alignment, the efficiency and the operational effectiveness of the cataract processes. We applied the framework three times during the case studies. In ***chapter five*** we provide a brief introduction to the cases studies in terms of the content of chapter six, seven and eight and the way we collected the information and data during the case studies. ***Chapter six, seven and eight*** elaborate on the case studies in The Rotterdam Eye Hospital (Rotterdam, The Netherlands), Moorfields Eye Hospital (London, The United Kingdom) and in The New York Eye and Ear Infirmary (New York, The United States of America). In ***chapter nine***, we look at the results of the case studies. We discuss the relevance of the hypotheses and examine if process-alignment is positively associated with efficiency and/or operational effectiveness of the cataract process. In ***Chapter ten,*** we present the recommendations for The Rotterdam Eye Hospital, Moorfields Eye Hospital and The New York Eye and Ear Infirmary to improve their process-alignment. ***Chapter eleven*** presents the conclusions of the research. In the final chapter, ***chapter twelve***, we reflect on the course of the research and on what we could have done better.

2. Problem exploration

In this section we elaborate on the background of the research (§ 2.1), the relevance of the topic (§ 2.2), the objective (§ 2.3), the research questions (§ 2.4) and the research approach (§ 2.5).

2.1 Background

After two completed studies in the field of focused factories in hospital care, within the project of the University of Twente and Maastricht University, this research elaborates on the gathered experiences and results of these previous investigations. It contributes to the knowledge of focused factories in hospital care, aimed at the design of the care delivery system; the process-alignment. Three international good practice eye hospitals are compared to gain insights into the design, the efficiency and the operational effectiveness of the care delivery systems. The comparison doesn't include the whole organization, but focuses on one specific care delivery process; the cataract process. The cataract process is defined within the framework of this research as:

The cataract process

The successive sub-processes a cataract patient go through in order to cure the cataract, starting with the first out-patient consultation in the eye hospital and ending after the first review after surgery.

Some specific characteristics qualified the cataract process for this research. ***The first*** is the limited number of emergency cataract treatments. As cataract has to ripe over a couple of years, patients are in a position to wait for their treatment. This gives the hospitals the opportunity to plan cataract treatments carefully in advance, and to design an organizational structure that doesn't has to cope, on regular basis, with emergency cases. ***The second characteristic*** is that the cataract process doesn't leave much room for variations in the field of which sub-processes are required on medical basis during the treatment. This makes the process well suited for a comparative study.

Qualifying characteristics of the cataract process for this research

- The ability to plan treatments in advance.
- The limited variation in the treatments.
- The lack of emergencies treatments.

Process-alignment concerns the design of the care delivery system and the alignment of the successive sub-processes and capacities. ***Efficiency*** is defined by Richard Daft (2004) as "the amount of resources used to achieve the organization's goals" (Daft, 2004). This definition is based on the quantity of raw material, money and employees necessary for producing a given level of output. Veillard et al. (2005) quote a definition of hospital efficiency used by the World Health Organization: "a hospital's optimal use of inputs to yield maximal outputs, given its available resources". Richard Daft (2004) also defined effectiveness as: "the degree to which an organization achieves its goals" (Daft, 2004). But what are in this case the organization's goals? The organizational objective is to establish an efficient and operational effective cataract process. So, the organizational objective doesn't help us to define operational effectiveness.

In order to explore the definition of operational effectiveness, we refer to the findings of the Committee on the Quality of Health Care in America (Committee on the Quality of Health Care in America, 2001). This committee was formed in June 1998 and charged with developing a strategy that would result in a substantial improvement in the quality of health care over the next 10 years. One of their recommendations states that all health care organizations, professional groups, and private and public purchasers should pursue six major aims.

Health care should be (Committee on the Quality of Health Care in America, 2001):

1. **Safe**; avoiding injuries to patients from the care that is intended to help them.
2. **Effective**; providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and overuse, respectively).
3. **Patient-centered**; providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions.
4. **Timely**; reducing waits and sometimes harmful delays for both those who receive and those who give care.
5. **Efficient**; avoiding waste, including waste of equipment, supplies, ideas, and energy.
6. **Equitable**; providing care that doesn't vary in quality because of personal characteristics such as gender, ethnicity, geographic location, and socio-economic status.

Healthcare is effective if provided services are based on scientific knowledge. However, since we don't intend to examine medical outcomes, this definition isn't appropriate for this research. The same applies for ***safety***. ***Equity*** tends towards an ethical, social restriction of health care and is therefore not convenient. ***Patient-centeredness*** prescribes that the delivered care should be respectful and responsive to the patient's preferences, needs and values. We believe that this definition inclines towards a prescriptive recommendation and is therefore sensitive to subjectivity. This makes ***patient-centeredness*** difficult to compare between hospitals dealing with different patient populations that support dissimilar values and believes. ***Timeliness*** is related to patient-centeredness but more convenient to measure and compare. For this reason, we use this aim of health care to correspond with the ***operational effectiveness*** of the cataract process.

Operational effectiveness
The degree to which the cataract process reduces waiting times and potentially harmful delays for both those who receive and those who give care.

The definition of efficiency that we use during this research is a combination of the definition of the Committee on the Quality of Health Care in America (i.e. to focus on avoiding waste), and the definition of Richard Daft (i.e. to focus on minimizing the amount of used resources).

Efficiency
The degree to which the process avoids waste and minimizes the amount of resources used in delivering care.

2.2 Relevance

The Dutch health care sector has changed over the last three years. The introduction of a new health care insurance system, of Diagnostic Related Groups in hospital financing and the rise of Independent Treatment Centers are changing health care into a demand driven system. The government introduced market elements to create higher efficiency in the sector, which should lead to increased quality and reduced costs. In order to achieve a higher efficiency, business concepts of the manufacturing sector are implemented in health care. Focused Factory is an example of such a concept. The focused factory concept was introduced by Skinner (1974) in manufacturing, and defined as: "a plant established to focus the entire manufacturing system on a limited, concise, manageable set of products, technologies, volumes, and markets precisely defined by the company's strategy, its technology, and its economics" (Skinner, 1974). Focusing reduces the number of conflicting elements in a manufacturing system, leading to an increase of the performance of the system (Skinner, 1985). Therefore, focused manufacturing systems will outperform 'traditional' manufacturing systems

(Hill & Woolley, 1993). According to Bredenhoff et al. (2007), focusing increases an organization's opportunity to design efficient and effective service delivery systems. They conclude from the literature on manufacturing and services that focus seems to contribute to consistent quality and cost-effectiveness (Bredenhoff et al., 2007). Herzlinger (1997) was the first to propose the concept of Focused Factories as an appropriate label for new organizational concepts in hospital care.

Bredenhoff, van Lent, and van Harten (2007) made the following assumptions concerning the claims on cost and quality performance in focused hospital care (Bredenhoff et al., 2007):

Assumptions concerning the performance of focused hospital care

- Outcomes reached in Focused Factories are believed to be better than the outcomes reached in general hospitals.
- Practice makes perfect. If physicians and teams deliver a specific type of care more frequently, they get more experienced.
- Focusing increases efficiency. As physicians and teams gain insights in their process, opportunities for standardization and dedicated lay-outs present themselves. (Bredenhoff et al., 2007)

As special emissary of the Dutch minister of Health, Welfare and Sport, Peter Bakker (Chief Executive Officer TNT Post, 2004) describes the Rotterdam Eye Hospital as a pioneer in patient logistics. Bakker (2004) claims that logistic improvements in hospitals are inherent to important quality improvements. One of the examples of logistic improvements in The Rotterdam Eye Hospital is the Cataract Surgery Clinic. This focused factory separates cataract surgeries from the other surgeries to increase the efficiency of the cataract process.

The subject of this thesis is about the ***efficiency*** and ***operational effectiveness*** of care delivery systems. Are certain care delivery systems more ***efficient*** and/or more ***operational effective*** than others? And is there any association between the ***design of the care delivery systems*** and the ***efficiency and operational effectiveness***?

2.3 Objective

This research elaborates on two previous studies carried out within the framework of the cooperation between the University of Twente and Maastricht University. This cooperation is established to gain more insights into focused factories in hospital care. The aim of this research is to investigate the efficiency and operational effectiveness of care delivery systems in focused factories to increase the knowledge about the process-alignment concept by comparing the cataract processes of three international good practice eye hospitals.

We compare the hospitals by means of a framework that we formulated after studying the literature and the cataract process in The Rotterdam Eye Hospital. The objective is formulated as follows:

The objective

To study the ***association*** between process-alignment, efficiency and operational effectiveness of care delivery systems in focused factories by analyzing and comparing the cataract processes of three international good practice hospitals.

Association

Two variables measured on the same process are associated when some values of one variable tend to occur more often with some values of the second variable than with other values of that variable.
(Moore & McCabe, 2005)

We studied the ***association*** instead of ***correlation*** between process-alignment, efficiency and operational effectiveness as correlation is defined by Moore & McCabe (2005) as: "the direction and strength of the linear relationship between two quantitative variables". We believe that we are unable to demonstrate linear relations between the variables within the framework of this research.

2.4 Research questions

The answers to the research questions enable us to accomplish the objective of the research. We formulated two main research questions and eight central questions.

Main research questions

I. What is the relation between process-alignment, efficiency and operational effectiveness of care delivery systems in Focused Factories?

II. What recommendations can be made concerning the process-alignment of the cataract process of The Rotterdam Eye Hospital, Moorfields Eye Hospital and The New York Eye and Ear Infirmary?

Central research questions

1. What does literature describe about process-alignment in relation to focused factories?
2. What does literature describe about process-alignment in relation to efficiency and operational effectiveness?
3. What method can be used to study process-alignment?
4. How should the method to study process-alignment be applied to the cataract process?
5. What method can be used to compare process-alignment?
6. How should the method to compare process-alignment be applied to the cataract process?
7. How are the cataract processes organized in the three eye hospitals?
8. What are the differences and similarities between the three eye hospitals?

2.5 Research approach

The research approach describes what we have to do in order to achieve the research objective.

Research approach

1. The ***first step*** is to identify what process-alignment is and what focused factories are. We carry out a literature study to define clear definitions and to obtain the information available concerning process-alignment in relation to focused factories. We briefly elaborate on the disease cataract and the incidence and prevalence of cataract in the different countries.
2. The ***second step*** is to develop a framework for analyzing and comparing the process-alignment, the efficiency and the operational effectiveness of the cataract process. We apply this framework during the case-studies to generate the information we need to answer ***research question I***.
3. The ***third step*** is to analyze the three cases by applying the framework. The hospitals verify and validate the results to ensure that the information we use is correct and confirmed.
4. The ***fourth step*** is to compare the results of the three cases by using the framework.
5. The ***fifth step*** is to draw conclusions as a result of the information we obtained by applying the framework. We examine the association between process-alignment in focused factories and the efficiency and operational effectiveness of care delivery systems in hospital care.
6. The ***sixth step*** is to make recommendations to The Rotterdam Eye Hospital, Moorfields Eye Hospital and The New York Eye and Ear Infirmary regarding the process-alignment of their cataract processes.
7. The ***seventh*** s***tep*** is to make recommendations for further research and to reflect on the course of our project.

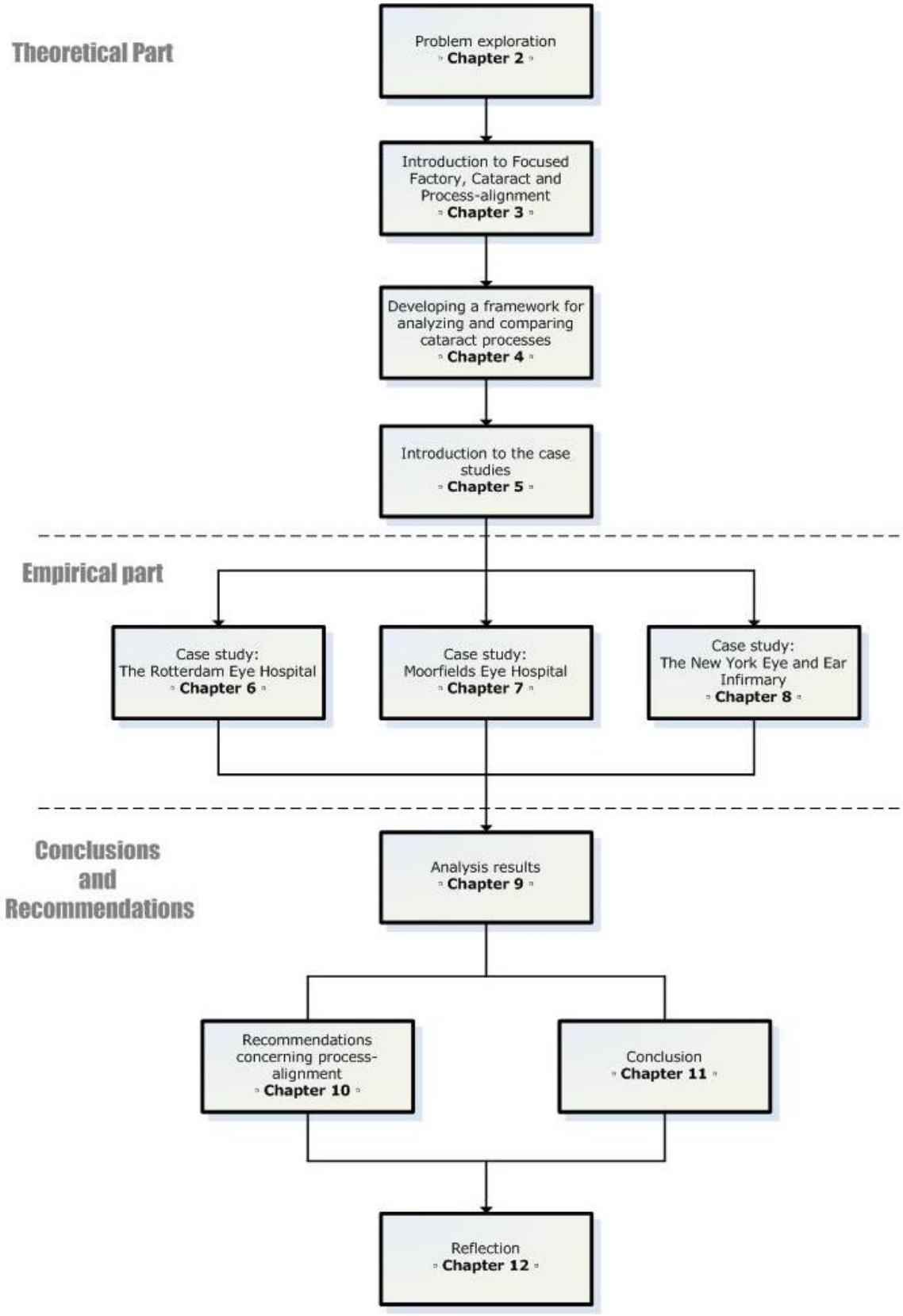


Figure 1; Chapters of the thesis

3. Introduction to Focused Factory, Cataract and Process-alignment

This chapter elaborates on the focused factory concept, the disease cataract and discusses the term 'process-alignment'. We carried out a systematic literature study to find appropriate information. The used keywords were: ***focused factory***, ***process-alignment***, ***product line management***, ***fit***, ***internal fit***, ***cataract***, ***patient pathways*** and all possible combinations with ***health care***, ***hospitals, efficiency*** and ***operational effectiveness***. We used the references of qualified papers to find new articles. We consulted the library of the University of Twente, relevant internet databases, text books and e-journals.

3.1 Focused Factory in manufacturing

In 1974, Wickham Skinner introduced a new approach to manage manufacturing. The idea behind this approach is that "producing many products for numerous customers in a variety of markets, thereby demanding the performance of a multiplicity of manufacturing tasks all at once from one set of assets and people, results more often than not in a hodgepodge of compromises, a high overhead and a manufacturing organization that is constantly in hot water with top management, marketing management, the controller and customers" (Skinner, 1974). During the period 1970-1980, the threat posed by foreign competition, the expensive U.S. labor, the unemployment and the low productivity growth rate maneuvered the U.S. industrial sector in a 'productivity crisis'. To overcome the crisis and to shift the competitive balance in favor of the U.S. industry, Skinner (1974) introduced the concept of focused manufacturing and claimed that: "a factory that focuses on a narrow product mix for a particular market niche will outperform the conventional plant, which attempts a broader mission" (Skinner, 1974). Focused manufacturing is based on the concept that simplicity, repetition, experience, and homogeneity of tasks breed competence (Skinner, 1974). "The focused factory does a better job because repetition and concentration in one area allow its workforce and managers to become effective and experienced in the task required for success. The focused factory is manageable and controllable. Its problems are demanding, but limited in scope, according to Skinner (1974). Skinner also introduced the 'Plant within a plant' (PWP) notion. Companies that are involved in different products, technologies, markets, or volumes should divide their facilities both organizationally and physically into different PWPs for the purpose of serving each product, technology, market, or volume separately. Each PWP has its own facilities in which it can concentrate on its particular manufacturing task, using its own workforce management approaches, production control, and organization structure (Skinner, 1974).

Hill and Duke-Wooley (1983) argue that manufacturing facilities can orientate towards a product focus or a process focus. Product focus implies that the facility is able to meet the needs of a range of products, including product development. Process focused facilities are designed to meet the needs of a relatively short range of products, normally with high volumes and/or similar process requirements. Hill and Duke-Wooley (1983) claim that focus is based on the concept that there needs to be a set of tasks in the key areas of manufacturing which are consistent with one other and are also consistent within the manufacturing strategy necessary to support the corporate marketing requirement (Hill and Duke-Wooley, 1983).

Mukherjee et al. (2000) claim that a key concept underlying the idea that routines are the skills of an organization is that organizations remember by doing. Firms remember production line skills through executing them. They also argue that the purpose of focus is to excel in a skill, and since skills are combinations of routines that production lines remember by doing, achieving focus in the task of a production line requires that

the line execute the task repetitively. In focusing a production line, Mukherjee et al. (2000) state that the major task for the management of a manufacturing company is to:

> "design a set of routines that are coherent components of a specific targeted skill set and establishing a process in which employees, machines, and systems can repeat the routines without a need for explicit reconsideration each time the line executes a step" (Mukherjee et al., 2000)

Therefore, a focused manufacturing facility limits the number of manufacturing routines the facility requires of its operators. This suggests that in general, the fewer the routines, the more focused a facility becomes (Mukherjee et al., 2000).

Hayes and Wheelwright (1984) studied plant focus and determined a strong positive association between operating margin and company focus. They concluded that companies with fewer production lines were found to be more profitable than companies with more production lines (Hayes and Wheelwright, 1984).

In conclusion, research has led to mainly positive publications about focused factories in the manufacturing industry, although focus isn't particular assigned to one specific company design or facility property (van Lent, 2006). Focus in manufacturing is related to factors such as the number of product lines, process type, age of the plant, and plant size (Pesch & Schroeder, 1996).

After the introduction of focus in manufacturing, some success stories were described in the service sector. This resulted in research in the field of the applicability of focus in the service industry and in the health care sector. Do the positive effects of focusing in the manufacturing industry also appear when focusing is applied in health care organizations?

3.2 Focused factory in Health Care

Focused factories were introduced in hospital care by Herzlinger in 1997. She wanted to contribute to a more cost-effective American health system by proposing a solution to the request for more efficient health care. According to Herzlinger (1997) and Chilingerian (1992), hospitals using the concept of focused factories should be able to achieve a competitive advantage, mostly based on price, delivery times and quality. Herzlinger (1997) describes the focused factory as: "A factory characterized by a multidisciplinary group of people who work together to achieve a clear, limited objective. (..) the team members are guided by thoughtful operating procedures and continually monitor their success in achieving their objectives, using objective, quantitative measures. The large volume of work executed in a focused factory, the harmony and fluidity achieved by its team members, and the attention paid improving the operational processes result in continual process refinements, quality improvements, and cost reductions" (Herzlinger, 1997). Bredenhoff et al. (2004) translated the work of Skinner to the health care sector. They formulated the following observation: "Skinner uses the focused factory concept to create (routine) processes that are predictable and easy to plan. For hospitals this implies that a part of the hospital is focused on and designed for the treatment of a specific group of patients. This should improve the efficiency, safety, patient-centeredness and timeliness of the treatment process" (Bredenhoff et al., 2004).

We use the definition of a focused factory in hospital care formulated by Bredenhoff et al. (2007):

Focused factory in hospital care
An organization or (autonomous) organizational unit which care-delivery system is directed towards a well-defined and limited group of patients and/or a limited range of services offered, with a high degree of process-alignment (Bredenhoff et al., 2007)

This definition shows two dimensions for hospitals to focus on. The first dimension is to focus on ***patient groups***, which are defined by illness, diagnosis or complaint. The second dimension is to focus on ***offered services***, defined as the treatments offered, or the technologies and/or techniques used. Bredenhoff et al. (2007) believe that in order to study the effects of focusing on the care delivery system, one should distinguish different types of focus. Therefore, they propose a classification matrix identifying three basic types of focused factories in hospital care, namely (Bredenhoff et al., 2007):

- **Type 1,** Non-focused factories:
  These hospitals are considered to be non-focused. Non-focused factories are organizations with low degrees of focus on both dimensions. An example is the general hospital.
- **Type 2**, Specialty based focused factories:
  These hospitals are focused on a specific group of patients with similar diagnosis or illnesses. Specialty based focused factories offer a particular patient group a wide range of services.
- **Type 3,** Delivery based focused factories:
  These organizations are directed towards a specific type of treatment, technique or technology. This particular service is offered to a large number of patient groups.
- **Type 4,** Procedure based focused factories:
  These organizations are focused on both dimensions. Procedure based focused factories aim at one particular patient group and offer them one distinct type of service.

To position organizations in the classification matrix (figure 2), Bredenhoff et al. (2007) developed a preliminary measurement instrument. This instrument measures the focus on both dimensions. For each dimension a degree of focus is calculated. For scores exceeding 50, they argue that it is likely that the organization is (to a certain degree) focused.

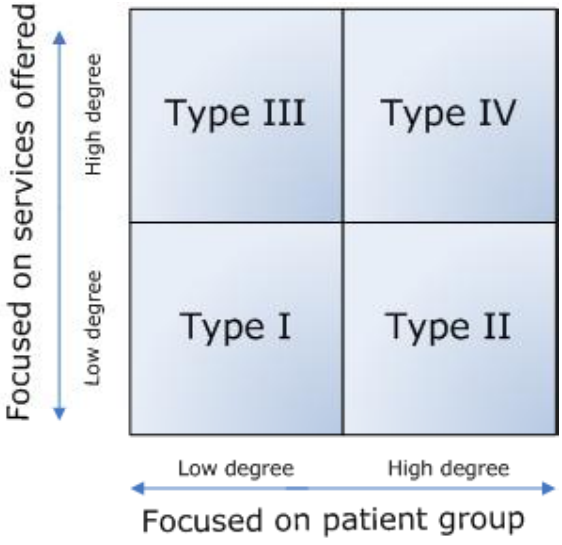


Figure 2; Classification matrix focused factories (Bredenhoff et al., 2007)

Huckman and Zinner (2005) studied the question: 'does focus improves operational performance after accounting for scale, learning and selection effects?' They state that scale, learning and selection are correlated with, but distinct from operating focus (Huckman & Zinner, 2005). According to Huckman and Zinner (2005), operational focus stems primarily from the reduction of variation and complexity through such as standardized processes, simpler scheduling, and fewer product changeovers. In their research, they find evidence to agree on the proposition of Skinner that limiting the number of conflicting activities leads to higher performance (Huckman & Zinner, 2005).

To gain a better understanding of focus applied to the health care sector, McLaughlin et al. (1995) discussed the benefits and disadvantages of focusing in health care. The disadvantages are mostly related to a loss of economies of scale and scope. They describe as an example the surgeon that has set up a center for cataract surgery through which the provided range of eye surgeries is reduced. To provide enough cataract referrals it is required to contact more primary caregivers, thus increasing the marketing costs. The rationale for broadening the production line or diversification into additional markets is to increase the production volume, to utilize capacity and to reduce the unit costs. On the other hand, economies of scope may also produce economies of scale: the higher the volume, the lower the cost per unit (McLaughlin et al., 1995).

Yang et al. (1992) discussed focus in ambulatory surgery centers (i.e. Day Surgery Clinics). The American Hospital Association (2007) defines ambulatory surgery as:

Ambulatory Surgery
Scheduled surgical procedures provided to patients that don't remain in the hospital overnight.
(The American Hospital Association, 2007)

They examine the benefits and disadvantages of dedicated operating and recovering rooms with inpatient service by introducing a plant-within-plant or a separated facility for ambulatory surgery. Yang et al. (1992) state that focusing makes ambulatory surgery a win-win strategy for patients, doctors, and payers. Surgeons have greater schedule reliability as they don't have to compete with such emergencies as shootings, car accidents or heart attacks (Yang et al., 1992). The perceived relative advantages of separated operating and recovering rooms were greatest for (Yang et al., 1992):

- Patients not losing priority to inpatient surgery
- Patients receiving more individual attention
- Patient compliance with instructions
- A comfortable staff working environment
- Lower costs
- Scheduling efficiency
- Surgeon acceptance
- Low overhead
- Patients no-shows
- Patients transported to and from the unit

The overall conclusion of Yang et al. (1992) is that segmenting the market and then focusing a facility on specific segments does lead to a better fit between the production process and the market's demands (Yang et al., 1992).

The main objective of the research of Casalino et al. (2003) is to examine if specialized facilities lower costs or increase quality, or both? Their data showed that having a facility that is designed specifically for specific needs increases the productivity, decreases the costs, and increases the quality (Casalino et al., 2003). The reason behind the increased quality in specialty facilities is that the physicians and other staff work together daily providing the same services over and over again.

3.3 Cataract and the cataract process

In this section we introduce to the disease cataract, elaborate on the prevalence and incidence of cataract in the case countries and we enlarge upon the cataract process as defined in section 2.1.

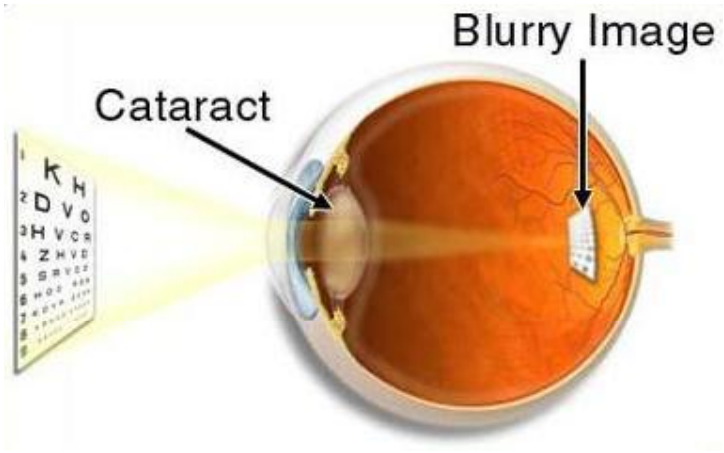
Cataract

The lens is a biconvex, transparent, flexible structure that can change shape to allow precise focusing of light on the retina. In youth, the lens is perfectly transparent and has the consistency of hardened jelly. However, as we age it becomes increasingly hard and opaque. Cataract ('waterfall'), which results from this process, is a clouding of the lens and causes vision to become hazy and eventually cause blindness in the affected eye. Some cataracts are congenital, but most result from age-related hardening and thickening of the lens or are a secondary consequence of diabetes mellitus. Heavy smoking and frequent exposure to intense sunlight increase the risk for cataract, whereas long-term dietary supplementation with vitamin C appears to significantly decrease the risks (Marieb, 2000).

Cataract

Cataract is a clouding of the lens and causes vision to become hazy and eventually cause blindness in the affected eye. (Marieb, 2000)

A cataract starts out small, and has little effect on the patient's vision in the beginning. The patients will experience that their vision becomes a little bit blurred, like looking through a cloudy piece of glass. Cataract makes light from the sun, or a lamp, seem too bright or glaring and colors may not appear as bright as they once did. If patients experience such symptoms, they may decide to visit their optometrist or GP. The underlying principles for the optometrist or GP to refer a patient to an eye hospital should be according to The Royal College of Ophthalmologists (2004):



- Patient should have sufficient cataract to account for the visual symptoms.
- The cataract should affect the patient's lifestyle.
- The patient should wish to undergo cataract surgery.

The volume of cataract surgery has increased significantly around the world in the last past years. In many areas cataract surgery forms over half of all ophthalmic surgeries carried out each year (Stunevi et al., 1995) and in a number of countries cataract surgery became the most common elective surgical procedure (Keeffe & Taylor, 1996). In the United Stated of America, cataract surgery is the most common surgery executed in the medicare population (American Academy for Ophthalmology, 2000).

Cataract surgery

The current treatment of cataract is surgical removal of the human lens and replacement with a plastic intraocular lens (IOL). We focus on the process that takes place before, during and after the surgical replacement of the lens. The aims of modern cataract surgery are (Royal College of Ophthalmologists, 2004):

- Restoration of vision to meet the patient's needs.
- Achievement of the desired refractive outcomes.
- Improvement in quality of life.
- Ensuring patient safety and satisfaction.

During surgery, the ophthalmologist makes a three millimeters incision on the side of the cornea. The cornea is a transparent tissue that covers the front surface of the eye and serves to transmit light to the eye. The ophthalmologist inserts subsequently a tiny probe into the eye. This device emits ultrasound waves that soften and break up the clouded lens so that it can be removed by suction. The IOL is often folded and passed through the tiny incision where it is opened inside the capsular bag. The used incision is generally self-sealing and stitching up is therefore not necessary. The surgery takes about 30 minutes on regular basis and is normally pain free.

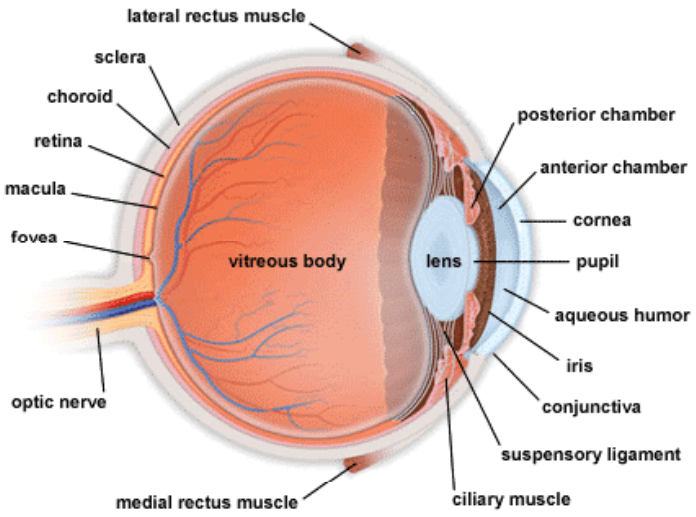


Figure 3; Anatomy of the eye (Freehold Ophthalmology, 2008)

Prevalence and incidence

Incidence
The number of ***new*** patients that are affected by a disease in a defined population in a defined period of time. (Elsevier health care, 2003)

Prevalence
The total number of patients that are affected by a disease in a defined population in a defined period of time. (Elsevier health care, 2003)

The prevalence of cataract in the Netherlands was one of the five fastest growing prevalence numbers in the period 1990-2000 (RIVM, 2002). In 2000, more than 260.000 patients were affected by cataract. The incidence number of that year was 65.000 patients (Bol, 2003). The most recent information concerns the year 2003 in which the size of the population was 16,1 million people (CBS, 2008). The incidence and prevalence numbers in 2003 in the Netherlands were (RIVM, 2006):

	Incidence	Prevalence
Total	60.300	343.700 (2.1% of the total Dutch population)

Table 1; Incidence and prevalence of cataract in the Netherlands in 2003 (RIVM, 2006)

The North London Eye Study provides prevalence data specifically for visually impairing cataract in one or both eyes in a random sample of 1547 people of 65 years and older in an outer metropolitan district (Reidy et al., 1998). It is estimated that 2.4 million people in England and Wales have visually impairing cataract in one or both eyes and a further 225.000 new cases of visually impairing cataract are expected each year. The 5-year cumulative incidence is estimated at 1.1 million new cases among the population (Reidy et al., 1998). The size of the population of England and Wales in 1998 was 52.5 million people (National statistics, 2008).

	Incidence	Prevalence
Total	225.000	≈ 2.400.000 (≈ 4,6% of the total Wales and England population)

Table 2; Incidence and prevalence of cataract in England and Wales in 1998 (Reidy et al., 1998)

20.5 million patients are affected by cataract in The United States of America in 2004. The number of patients is estimated to rise to 30.1 million people in the next 20 years, an increase of 50% according to the American Academy of Ophthalmology in 2004. The expected rise corresponds with an incidence of 481.250 new patients per year.

	Incidence	Prevalence 2004	Prevalence 2024
Total	≈ 481.250	20.475.000 (17.2% of the total USA population)	≈ 30.100.000

Table 3; Incidence and prevalence of cataract in The USA in 2004 and 2024 (AAO, 2004)

The cataract process

The cataract process is defined in section 2.1 as:

> 'The successive sub-processes a cataract patient go through in order to cure the cataract, starting with the first out-patient consultation in the eye hospital and ending after the first review after surgery'

The process design of cataract processes differ among different hospitals. In 2000, the NHS Executive published a document to assist managers and health professionals to review and improve the management of their cataract services. The NHS confirms that there is considerable variation in the way services are organized, without apparent differences in the outcomes for patients (NHS, 2000). For example: in some areas, patients visit the eye health services three visits to have their cataract diagnosed and treated. Whilst in others, seven or eight visits are required. The NHS (2000) claims that:

> 'Redesigning the cataract service from the patient's point of view, and implementing best practices in service organizations, have been shown to result in greater patient satisfaction, a more efficient service, shorter waiting times and higher overall rates of cataract surgery' (NHS, 2000).

The NHS-guidance is about how services are organized. It helps managers to identify where services can be made more effective, and how the accessibility of the services can be improved. However, the NHS places the comment that there is no single 'right way' to organize cataract services, as local circumstances vary. This implies that they are unable to provide a checklist which guarantees the best performance possible. They only propose directives and bring up ***good practices***. The NHS (2000) endorses the statement that delays and restricted access are the result of poorly designed, costly systems. Improving the design of the system can reduce delays and reduce costs (NHS, 2000).

Figure 4 displays two different cataract patient's pathways. Each blue square box corresponds to one visit to the hospital. The red boxes take place outside the hospital and are excluded from this research. The left figure

shows the traditional patient's pathway and the right figure shows a streamlined pathway, proposed by the NHS. The NHS (2000) distinguishes straightforward cataract patients. Straightforward cataract patients are affected by uncomplicated cataract, no comorbidity, and normal general health status. The patient needs relatively less medical attention and stands a minimal change of complications during and after surgery.

Straightforward cataract patient
Cataract patient that is affected by uncomplicated cataract, no comorbidity, and normal general health status. The patient needs relatively less medical attention and stands a minimal change of complications during and after surgery.

The proposed streamlined pathway (right figure) is especially convenient for straightforward cataract patients.

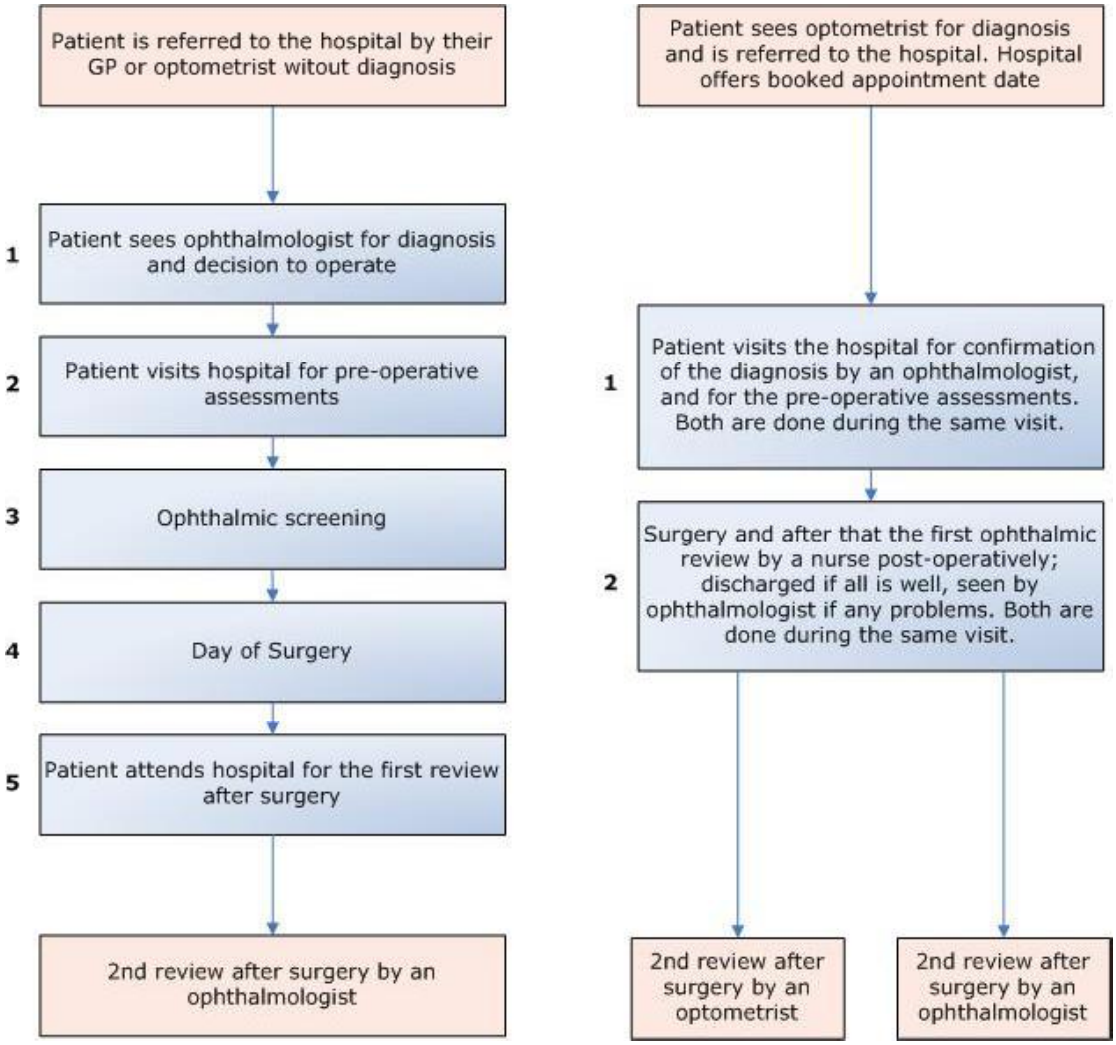


Figure 4; (Left) Traditional patient's pathway. (Right) Proposed, streamlined patient's pathway (NHS, 2000)

The cataract process ends after the first review after surgery. The traditional pathway includes five visits to the hospital and the proposed streamlined pathway includes only two visits. The streamlined pathway is called a 'fast-track' as it includes fewer visits to the hospital. The term 'fast-track' is commonly used in guidelines concerning cataract and by experts in the hospitals. However, it isn't clearly defined in literature. We define the cataract fast-track as:

Cataract fast-track

A cataract patient's pathway that comprises the minimum number of visits to the hospital and is minimally consuming for the hospital's resources (e.g. personal, time and medical technology). The fast- track is especially suitable for straightforward cataract patients.

After comparing the two pathways, we distinguished four corresponding phases in the cataract process:

1. Diagnostic phase (i.e. first out-patient consultation)
2. Pre-operative phase (e.g. nursing anamnesis, ECG, blood tests, internist, biometry, anesthesiologist, pre-operative ophthalmic screening)
3. Surgical phase (i.e. surgery)
4. Post-operative phase (i.e. first review after surgery)

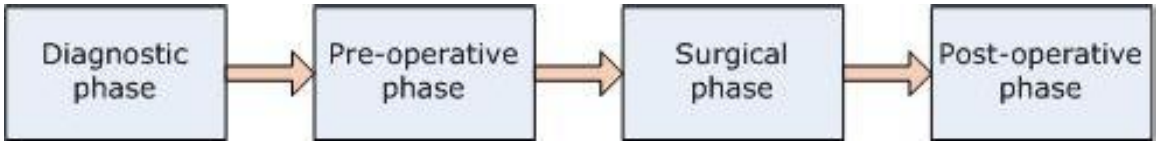


Figure 5; Phases of the cataract process

3.4 To explore process-alignment

Bredenhoff et al. (2007) deducted the term 'process-alignment' from what is called in business literature 'fit' or 'alignment'. The principle behind the term isn't new. However, the literal term isn't defined in literature yet. Bredenhoff et al. (2007) describe process-alignment as: "the design of an efficient and effective care delivery system". They emphasize that focusing increases an organization's opportunity to design efficient and effective service delivery systems and that process-alignment is therefore an essential element of successful focused factories. In their opinion, process-alignment is related to the design of the care delivery system and concentrates on the connection between succeeding processes. Process-alignment strives for seamless transitions between sub-processes, and preventing interruptions from other processes, in order to increase the efficiency and effectiveness of the process. The latter brings us back to the term 'fit'. Venkatraman (1989) defined fit as: "the degree to which operational elements match the business strategy". Earlier, Thompson (1967) differentiated the concept as the fit between the organizational structure, strategy, and/or the wider environment (external fit) and the fit among groups or units within the organization (internal fit). Miller (1992) argues that it is commonly held that organizations must achieve fit with their external environment and among their elements of structure and process. Miller (1992) addresses three aspects of internal fit: fit among variables of structure, between structure and process, and among variables of process (Miller, 1992) Research dealing with internal fit, which is most relevant in our case, stems primarily from Skinner's work. Skinner claimed that a 'good' internal fit is one which basic manufacturing policies are structured so that those are focused on, and consistent with one explicit manufacturing task (Skinner 1974). In this description one can distinguish a significant similarity between internal fit and factory focus. In accordance with the statement of Bredenhoff et al. (2007) that focusing increases an organization's opportunity to design efficient and effective service delivery systems, and that process-alignment is an essential element of successful focused factories, we formulated our interpretation of process-alignment:

Process-alignment

The extent to which the sub-processes of a care delivery system fit to each other, and fit to the chosen type of focus regarding the served patients and offered services.

In order to:

- Smoothen the patient's flow through the process.
- Reduce waste.
- Reduce waiting times for as well patients as professionals.

By:

- Preventing interruptions from other processes.
- Synchronizing:
    - The executed primary and supporting procedures.
    - Operational planning systems.
    - Capacities.
    - Resources in the field of:
        - Personnel
        - Medical Technology
        - Knowledge

4. Developing a framework for analyzing and comparing cataract processes

This chapter describes the development of the framework for analyzing and comparing the cataract process regarding the process-alignment, the efficiency, and the operational effectiveness. The goals we aim to accomplish by applying the framework are:

Goals of applying the framework

1. To gain insights into the efficiency and the operational effectiveness of the cataract process.
2. To gain insights into the process-alignment of the cataract process.
3. To investigate the association between process-alignment, efficiency, and operational effectiveness of the cataract process.

We go through the following steps in order to achieve the above mentioned goals:

Step 1: To formulate a number of hypotheses and corresponding indicators to measure and describe the process-alignment of the cataract process.

Step 2: To draw up a number of comparable indicators to measure the efficiency and operational effectiveness of the cataract process.

Step 3: To review the availability, the comparability and the relevance of the formulated indicators.

Step 4: To modify the framework as a result of the ***step 3.***

Step 5: To measure the process-alignment by using the hypotheses and corresponding indicators.

Step 6: To measure the efficiency and operational effectiveness by using the indicators.

Step 7: To assess the reliability of the scores on the indictors.

Step 8: To assess the relevance of the hypotheses based on the scores on the indicators and our observations regarding the process-alignment.

Step 9: To explain the differences in the efficiency and operational effectiveness in the light of the differences in the extent of process-alignment.

We examine the efficiency and operational effectiveness of the cataract process as indicators of an efficient and effective cataract process. ***We assume that efficiency and operational effectiveness are the organizational objectives of process-alignment***. Subsequently, it is important to emphasize that we examine ***the first eye cases*** and don't take the second eye cases into consideration as it may possible for hospitals to organize the patient's pathway for the second eye treatment in a different way. This may hamper the comparison.

We used the following rules of comparison to improve the comparability of the case studies:

The Rules of Comparison

1. Only cataract patients.
2. We focus on the patients that start the process at the beginning of the pathway displayed in the flowchart (see sections 6.2, 7.2 and 8.2). This implies that we leave internal referrals from other specialties out of consideration.
3. We require the indicators for 2006.
4. Only cataract patients whose **first eye** is treated. The second eye cases are omitted[1].
5. We consider the cataract process that starts with the ***first out-patient consultation*** in the hospital and ends after ***the first review after surgery*** (i.e. same or next day review). The second review after surgery isn't included.

[1] Many patients are affected by cataract in both eyes. Research confirms that there is a great value to patients in operating cataract in the second eye as well (Laidlaw et al., 1998). If the second eye surgery takes place within 2-3 months and the biometry is executed on both eyes at the outset of the first treatment, all pre-operative assessments are still valid and there is no need for patients to visit the hospital again before the second surgery (NHS, 2000). A phone call is sufficient to check whether the patient's general health has changed. Since the design of the second eye's pathway may be significant different, the second eye cases are excluded from this research.

4.1 Hypotheses

In this section we describe the hypotheses to assess the process-alignment of a cataract process, based on:

- Walk-through experience in The Rotterdam Eye Hospital
- Interviews with experts of The Rotterdam Eye Hospital
- Literature on best-practices:
    - Actions on Cataracts (NHS, 2000)
    - Best Practice Patterns (American Academy of Ophthalmologists, 2000)
    - Cataract Surgery Guidelines (Royal College of Ophthalmologists, 2004)
    - Concept Cataract Richtlijn (Nederlands Oogheelkundig Genootschap, 2006)

We formulated the hypotheses according to our interpretation of process-alignment. To assure that the framework covers all relevant aspects, we discerned a number of themes in the definition of process-alignment and correspond each theme with a hypothesis.

The three main themes we distinguished are:

Main themes of process-alignment

- The fit between sub-processes:
    - The synchronization of executed primary and supporting procedures.
    - The synchronization of capacities.
    - The synchronization of used resources (in the field of personnel, material and knowledge).
    - The synchronization of operational planning systems.
- The fit between the sub-processes and the chosen type of focus (with regard to the served patients and offered services).
- Interruptions from other processes.

Each hypothesis is supported by an indicator to measure the extent of process-alignment and to compare the different cases after the case studies. We determine in advance if a higher score corresponds with higher or less extent of process-alignment. The scores on the indicators support us to formulate well-founded conclusions.

We use the four phases of the cataract process and the different themes of process-alignment to make sure that all significant aspects of the process and process-alignment are covered. In the end we conclude whether process-alignment is ***associated*** with increased efficiency and/or operational effectiveness. The latter leads us to the following main hypothesis that we accept or reject in the chapter 11, the conclusion.

Main hypothesis

A higher extent of process-alignment is ***positively associated*** with increased efficiency and operational effectiveness of the cataract process.

Positive association

Two variables are ***positively associated*** when above-average values of one tend to accompany above-average values of the other and below-average values also tend to occur together.
(Introduction to the practice of statistics, 2005)

4.1.1 Diagnostic phase

The first phase is the diagnostic phase. During this phase, the patient undergoes the first out-patient consultation with the ophthalmologist. The purpose of this out-patient consultation is, according to The Royal College of Ophthalmologists (2004):

- Confirm the diagnosis of visually significant cataract.
- Ensure the cataract is the cause of the visual symptoms.
- Determine if there is co-morbidity involved.
- Ensure the patient whishes to undergo cataract surgery and understands the risks.
- Formulate a surgical care plan.

The fit between different sub-processes

The diagnostic phase includes only the first out-patient consultation. This theme focused on the fit between the out-patient consultation and the sub-processes in the succeeding phases. We concern the connection between the out-patient consultation and the nursing anamnesis which is the start of the pre-operative phase. It is essential to assess ***the fit between the capacities and the operational planning systems*** of both sub-processes. In order to cover both aspects, we take a closer look at the patients that undergo all pre-operative assessments and the first out-patient consultation on the same day (i.e. to be diagnosed and prepared for surgery during one visit to the hospital). If both sub-processes don't take place on the same day, the process design isn't well aligned and causes an extra visit to the hospital.

Hypothesis 1
The process is better aligned when patients undergo the first out-patient consultation and all pre-operative assessments on the same day.

To measure and compare this hypothesis, we formulated the following indicator:

Indicator 1: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that undergo the first out-patient consultation and all necessary pre-operative assessments on the same day ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year***.

The next hypothesis is related to the fit between the diagnostic and the surgical phase. Some surgeons plan a redundant pre-operative ophthalmic screening before surgery when they have never seen the patient before in the preceding phases. The underlying principle of this behavior is the possibility or disability for ophthalmologists to plan patients on other surgeon's theatre lists. The ***fit between the used resources (i.e. personnel)*** may avoid the ophthalmic screening as the number of surgeons is as close as equal to the number of ophthalmologists that carry out the out-patient consultations. The ophthalmic screening may also be avoided ***by adjusting knowledge***, which is the preferred alternative to increase the process-alignment according to the authors. If straightforward cataract patients are labeled during the out-patient consultation, and the surgeons rely on that information later on in the process, they may decide to operate patients without any encounter prior to the surgery.

Hypothesis 2
Adjusting medical staff and/or knowledge between the diagnostic and the surgical phase avoids the redundant ophthalmic screening during the pre-operative phase, and has a positive effect upon the process-alignment.

Indicator 2: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that don't undergo an ophthalmic screening before surgery ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

The fit between sub-processes and the chosen type of focus

Organizations or organizational units may be focused on two dimensions: offered services and/or focus well-defined groups of patients (Bredenhoff et al., 2007). The fit between the sub-processes and the chosen type of focus can be assessed according to both dimensions as well. This theme is related to number of distinguished groups of cataract patients and to the (dissimilar) services these groups are offered. During the diagnostic phase, the ophthalmologist is able to separate:

- Straightforward cataract patients: patients that are affected by uncomplicated cataract, no comorbidity, and a normal general health status. The patient needs relatively less medical attention and stands a minimal change of complications during and after surgery.
- Non-straightforward cataract patients: patients with ocular comorbidity (e.g. glaucoma, macular disease, diabetic retinopathy), systematic health problems, secondary handicaps, or limiting social conditions.

Straightforward cataract patients need relatively less medical attention. This implies that in a situation whereby this type of patient isn't labeled, these patients may undergo redundant pre-operative assessments. An objective of process-alignment is to reduce waste. ***If straightforward patients are labeled and subsequently send through a less extensive 'separated' pathway (i.e. a fast-track)***, it reduces waste.

Hypothesis 3
Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Indicator 3: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that go through the fast-track ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

Interruptions from other processes

To assign dedicated resources to sub-processes can avoid interruptions from other processes. Dedicated resources are defined as:

Dedicated resources
Resources that are exclusively assigned to the cataract process. This implies that patients and professionals from other specialties can't make use of these resources.

Using dedicated resources (i.e. personnel, medical technology) minimizes the disturbances from other specialties and has a positive effect upon the process-alignment. With regard to the diagnostic phase, patients undergo the out-patient consultation during a general consulting hour or during a dedicated consulting hour (for cataract only). Using cataract-only consulting hours ***simplifies the operational planning, facilitates labeling straightforward cataract patients and avoids interruptions from other processes***.

Hypothesis 4
Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

Indicator 4: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of operated cataract patients that underwent the first out-patient consultation during a cataract-only consulting hour ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

4.1.2 Pre-operative phase

The pre-operative phase follows after the diagnostic phase. During this phase, all necessary sub-processes (i.e. pre-operative assessments) to prepare the patients for surgery take place. The pre-operative phase normally covers the following pre-operative assessments:

1. Nursing anamnesis
2. Biometry (measuring the axial length of the eye to determine the correct lens implant)
3. Blood tests
4. Electrocardiogram (ECG)
5. Consultation with an internist
6. Screening by an anesthesiologist

There are at most six different assessments to execute. When each assessment is carried out by a different actor, at most six actors are involved (e.g. the internist, the anesthesiologist, the nurse, an actor for the: biometry, ECG, blood tests). However, as it is possible that one actor fulfills multiple tasks, and we assume that the nurse isn't able to carry out the job of the internist and the anesthesiologist, at least two actors are involved (the internist or the anesthesiologist and one actor for all other tasks). In conclusion: there are at least two and at most six types of actors involved during the pre-operative phase.

The fit between different sub-processes
Not all cataract patients undergo the same pre-operative assessments. Some patients undergo only the biometry, whilst others undergo all pre-operative assessments. The hospital decides which assessments are necessary based on medical qualifications. In order to improve the ability to s***ynchronize the capacities, the used resources (in the field of personnel, material and knowledge) and the operational planning systems,*** it is recommended by the NHS (2000) to use protocol to make the cataract pathway uniform for patients with similar needs.

During the pre-operative phase, the admission date for surgery and the second review after surgery are planned. Planning both dates in the beginning of the process in discussion with the patient reduces uncertainty and anxiety for patients. As the patients have agreed on the dates at the outset, they are more committed to it which reduces the number of cancellations and facilitates the hospitals to plan their workload in advance (NHS, 2000).

Hypothesis 5
Planning the admission date for surgery in discussion with the patients, before they finish their pre-operative assessments and go home, has a positive effect upon the process-alignment.

Indicator 5: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that get an admission date for surgery during the pre-operative phase before they go home ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

The fit between sub-processes and the chosen type of focus

The different pre-operative assessments require different skills for employees. Some hospitals differentiate all the diverse tasks to different actors, whilst others do the opposite and train their staff to carry out multiple tasks. Differentiating the tasks to different actors is called ***job simplification*** (Daft, 2000). Job simplification is a job design that reduces the number of task a single person has to execute (Daft, 2000). Training staff to do multiple tasks is called ***job enlargement***. Job enlargement is a job design that combines a series of tasks into one new, broader job to give employees variety and challenge (Daft, 2000).

We believe that job simplification increases the possibility to reduce t***he extent of fit between the sub-processes*** within the pre-operative phase. If one actor fulfills multiple tasks, those multiple tasks become one sub-process such that the process design has to cope in a lower extent with the ***synchronizing of knowledge, personal, executed primary and supporting procedures, capacities and planning systems***. Therefore, we argue that job-enlargement leads to a higher extent of process-alignment, as fewer personnel is involved and handovers are reduced. Furthermore, job-enlargement increases the working flexibility of the members of staff (NHS, 2000).

As mentioned in the introduction of this section, there are at most six, and at least two actors involved in the pre-operative phase. Six actors involved correspond with a job design that is optimally ***simplified*** (0% job enlargement) and two actors involved correspond with a job design that is optimally ***enlarged*** (100% job enlargement). In case there are three, four or five actors involved, the percentages are interpolated and correspond with relatively 75%, 50% and 25% job enlargement.

2 actors	100%
3 actors	75%
4 actors	50%
5 actors	25%
6 actors	0%

Table 4; Percentage job enlargement

Hypothesis 6
When members of staff are trained to execute multiple tasks during the pre-operative phase (job enlargement), the process is better aligned.

Indicator 6: [Percentage; a ***higher*** percentage corresponds with ***higher*** extent of process-alignment]
The percentage job enlargement during the pre-operative phase [min 0%, max 100%]

The last hypothesis within this theme is about the pre-operative assessments in general. Many ophthalmologists believe that routine pre-operative testing (e.g. ECG, blood tests, internist) should be carried out before each cataract surgery for certain (age related) or for all patients. Schein et al. (2001) studied whether routine testing helps to reduce the incidence of intra-operative and post-operative medical complications. Their study was executed at nine centers and about 19000 elective cataract surgeries were randomly assigned to be preceded or not preceded by a standard set of medical tests in addition to history taking and physical examinations. The overall rate of complications was the same in the two groups. There also were no marked differences between the intra-operative and post-operative events. Analyses stratified according to age, sex, race, physical status, and medical history revealed no benefit of routine testing (Schein et al., 2001). Schein et al. (2001) conclude that routine medical testing before cataract surgery doesn't measurable increase the patient's safety during and after surgery. The cataract surgery guidelines (NHS, 2000) concur with these findings and state in their report that routine pre-operative testing for patients that undergo local anesthesia haven't been found to reduce the incidence of intra-operative or post-operative medical complications. These findings imply that in the light of reducing/avoiding waste, all pre-operative assessments except the biometry are redundant and therefore not in line with the organizational goals of an efficient and operational effective cataract process. There is ***no optimal fit between the offered services and the served patients*** when patients undergo redundant treatments.

Hypothesis 7
The less pre-operative assessments carried out, the higher the extent of process is aligned.

Indicator 7: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that haven't undergone any pre-operative assessments except the biometry and the nursing anamnesis ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

Interruptions from other processes
Pre-operative assessments are not only necessary for cataract patients during their treatment. Therefore, it is possible that cataract patients and other patients mix up during certain sub-processes whereby disturbances from other processes may influence the cataract process. For example: when all patients use the same resources, an emergency case of another specialty may delay a cataract patient, undoing the advantage of the cataract process that deals with a minimal number of emergency cases. To avoid these interruptions, hospitals can assign dedicated resources to certain sub-processes. Therefore, we hypothesize that using dedicated resources during the pre-operative phase has a positive effect upon the process-alignment. As certain sub-processes within the pre-operative phase are dedicated, whilst others are not, we established a method to determine for what part the resources in this phase are dedicated.

Not all patients go through all available sub-processes and not all sub-processes are equal sensitive for disturbances. We combined both aspects to determine, in discussion with the experts of The Rotterdam Eye Hospital, the impact of the dedication of the different sub-process on the dedication of all resources. For instance, if only the biometry and the blood tests are dedicated, the resources during the pre-operative phase are dedicated for 40%.

Biometry	30%
Anesthesiologist	15%
Blood tests	10%
Nursing anamnesis	30%
ECG	10%
Internist	5%

Table 5; Dedication of the pre-operative phase

Hypothesis 8
Using dedicated resources (e.g. personnel, medical technology) to execute the sub-processes in the pre-operative phase, has a positive effect upon the process-alignment.

Indicator 8: [Percentage; a ***higher*** percentage corresponds with ***higher*** extent of process-alignment]
The percentage dedicated resources used during the pre-operative phase of the cataract process.
[min 0%, max 100%]

4.1.3 Surgical phase

During the surgical phase, surgery takes place at two locations:

- In a regular operating room
- In a Day Surgery Clinic

Day Surgery Clinics are set up in a way that those use ***less resources*** (e.g. personnel, medical technology, hospital space) in comparison to regular operating rooms (NHS, 2000). Cataract surgeries are minimal invasive procedures and therefore particular suitable for Day Surgery Clinics. Surgeries in Day Surgery Clinics and in regular operating rooms give similar outcomes and complication rates for patients. Therefore, patients are preferred to undergo surgery in a Day Surgery Clinic to avoid the usage of redundant resources (NHS, 2000).

Hypothesis 9
The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

Indicator 9: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that undergo surgery in the Day Surgery Clinic ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

The fit between sub-processes

Some eye hospitals fulfils educational tasks. In the surgical phase it is important that there is a good fit between teaching surgery sessions and production surgery sessions. A surgery session is defined as:

Surgery session
A series of successive surgeries in one operating room with the same surgeon.

Production surgery sessions have the objective to process as many patients as possible per session. This isn't in line with the objective of teaching sessions. In order to synchronize the ***primary and supporting procedures, capacities and resources like personnel and knowledge***, it is recommended by the NHS (2000) to separate teaching sessions from production surgery sessions. Separating teaching sessions facilitates the possibility to sub-divide the teaching sessions according to the complexity of the surgeries as well (i.e. some cases are more convenient for junior or for senior students).

Hypothesis 10
Separated teaching theatre lists have a positive effect upon the process-alignment.

Indicator 10: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]
No; there are no separated teaching theatre lists for cataract surgery.
Yes; there are separated teaching theatre lists for cataract surgery.

Similar to what we discussed for hypothesis 10, applies for separating straightforward cataract patients (NHS, 2000). Separating straightforward cataract patients from non-straightforward cataract patients during surgery facilitates the adjustment of ***the operational planning systems and capacities***. Furthermore, it is possible to schedule more experienced surgeons to the non-straightforward theatre lists.

Hypothesis 11
Separated theatre lists for straightforward cataract patients have a positive effect upon the process-alignment.

Indicator 11: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]
No; there are no separated theatre lists for straightforward cataract patients.
Yes; there are separated theatre lists for straightforward cataract patients.

Cataract surgery is possible under local or general anesthesia. All forms of cataract surgery under local anesthesia demand significant patient co-operation throughout the procedure, but minimize the risk of surgical complications and facilitate the surgical procedure (The Royal College of Ophthalmologists, 2004). The following local anesthetic techniques are used:

- Topical anesthetics: drops numb the outermost layers of the cornea and the conjunctiva.
- Retro/peri-bulbar anesthetics: an injection numbs the entire eye.

General anesthesia is appropriate for patients that decline to have local anesthesia, are confused and unable to comply with the instructions, or are unable to communicate with the surgeon (The Royal College of Ophthalmologists, 2004). Although general anesthesia isn't an exclusion for day case surgery, it is normally an exclusion for the Day Surgery Clinic (The Royal College of Ophthalmologists, 2004). In the light of ***synchronizing the used resources*** and ***reducing waste***, a cataract process is better aligned if patients undergo local anesthesia as this is the fastest way to anaesthetize the patient's eye, needs minimal supervision by an

anesthesiologist and needs minimal recovery after surgery. Surgery under topical anesthesia doesn't even need supervision by an anesthesiologist (The Royal College of Ophthalmologists, 2004).

Hypothesis 12
The larger the number of patients that undergoes surgery under local anesthesia, the higher the extent of process-alignment.

Indicator 12: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that undergo local anesthesia ***per year.***
Denominator:
The total number of cataract patients that undergo surgery ***per year.***

Interruptions from other processes

Hypotheses 4 and 8 emphasize the use of dedicated resources during the diagnostic and the pre-operative phase. The same applies for the surgery resources. Cataract-only theatre lists or dedicated operating rooms run better as the time per case is consistent, the instrument sets are the same, and there is less risk of patients at the end of the list being delayed or cancelled due to earlier delayed cases (NHS, 2000). Since regular operating rooms are minimal used for cataract surgery, it isn't expected to have dedicated resources assigned to these operating rooms.

Hypothesis 13
Dedicated operating rooms in the Day Surgery Clinic, or using cataract-only theatre lists with dedicated personnel, has a positive effect upon the process-alignment.

Indicator 13: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]
No; there are no dedicated operating rooms in the Day Surgery Clinic or the hospital don't use cataract-only theatre lists.
Yes; there are dedicated operating rooms in the Day Surgery Clinic or the hospital use cataract-only theatre lists.

4.1.4 Post-operative phase

The last phase of the cataract process is the post-operative phase. After surgery, the patient should be discharged by an appropriately trained member of staff that ensures that (The Royal College of Ophthalmologists, 2004):

- The patient is comfortable and free of pain.
- The eye is examined.
- The patient is given post-operative instructions and medications.

There are four common ways to execute the first review after surgery:

- Review on the same day in the hospital.
- Review on the day after surgery in the hospital.
- Review by telephone one day after surgery.
- Self review.

The fit between sub-processes

As the objective of process-alignment is to minimize the number of visits to the hospital, the first review after surgery is preferred to take place:

- On the day of surgery in the hospital.
- By telephone the day after surgery.
- Self review at home.

According to the NHS (2000), the medical plus value to see the patient for the first review after surgery in the hospital is for most patients negligible. The Royal College of Ophthalmologists (2004) proposes to replace the face-to-face review with a review by telephone.

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

Indicator 14: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]

Numerator:

The number of cataract patients that don't come back to the hospital for the first review after surgery ***per year.***

Denominator:

The total number of cataract patients that undergo cataract surgery ***per year.***

Interruptions from other processes

As we discussed before. To avoid interruption from other processes in the post-operative phase, hospitals can assign dedicated resources to execute the first review after surgery.

Hypothesis 15

Using dedicated resources to execute the first review after surgery, has a positive effect upon the process-alignment.

Indicator 15: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]

No; there are no dedicated resources assigned to execute the first review after surgery.

Yes; there are dedicated resources assigned to execute the first review after surgery.

4.2 Efficiency and operational effectiveness

In this section we elaborate on measuring the efficiency and operational effectiveness of the cataract process. We benchmark the cases to determine which process is more efficient and/or more operational effective than others. The purpose of a benchmark study is to gain insights into the reason behind the measured results. One should find the process enablers that are responsible for a better performance of the process (Watson, 1993). We aim to explain the differences in the output-indicators (e.g. the efficiency- and operational effectiveness indicators) by differences in the process design (i.e. the process-alignment). The question is: 'Why do certain processes perform better than others?' In other words: 'Does the extent of process-alignment affect the achievement of the organizational objectives and does it make the processes score better on the output indicators?' To obtain this information, we formulated the output-indicators. According to M. van Vliet (1998), indicators that are used to compare different cases in a benchmark study should satisfy four critical conditions. These indicator should be (M. van Vliet, 1998):

- Relevant
- Measurable
- Comparable
- Representative

Ellen van Vliet (2001) developed a benchmark model to select suitable indicators for benchmarking eye hospitals in an international context. The model is particular meant to compare cataract processes. In order to find convenient indicators, seventy variables were selected and all tested on their suitability. The extent of suitability is determined by a combination of relevance, measurability and comparability of the indicators. In the end, only thirteen indicators turned out to be relevant, measurable and comparable and therefore suitable to included in the EYEOPENER-model. The first results of this research were presented during the Annual Board Meeting of The European Association of Eye Hospitals in Madrid, June 2001. The EYEOPENER-model is used as a guideline for the selected indicators proposed in the following two sections.

4.2.1 Indicators to measure *the efficiency* of the cataract process

An efficient care delivery system has to comply with the following definition, formulated in section 2.1:

> 'To avoid waste and to minimize the amount of resources used in delivering care'

The indicators to measure the efficiency are for that reason focused on avoiding/reducing waste, including waste of equipment, supplies, ideas and energy. The NHS (2000) determines that an efficient cataract process has to comply with the following objectives:

- To minimize the number of visits to the hospital.
- To minimize the throughput time of the sub-processes.
- To minimize the total time (treatment time + waiting time before and between treatments) a patient spend in the hospital during each visit.

We assume that the higher the number of patients the hospital treat per hour, the more efficient the sub-process is. To compensate a situation whereby the capacities are unlimited, we take the total costs per cataract treatment into account.

We use the following four indicators to measure the efficiency:

1. The average number of visits to the hospital during the whole treatment.
   [***The NHS (2000) states that an efficient cataract pathway includes as few visits to hospital as possible***]
2. The total costs per cataract treatment.
   [***Waste increases costs, reducing waste saves money. The total costs are relevant to assess the efficiency***]
3. The average number of patients treated during one out-patient consulting hour.
   [***In order to minimize the used resources, the throughput time should be as short as possible***]
4. The average number of performed cataract surgeries per hour.
   [***In order to minimize the used resources, the throughput time should be as short as possible***]

4.2.2 Indicators to measure the *operational effectiveness* of the cataract process

Operational effectiveness is defined in section 2.1 as:

> 'The degree to which the process reduces waiting times and sometimes harmful delays for those who receive and those who give care'

We use the following four indicators to measure the operational effectiveness:

1. Access time.
   [***The time between the referral and the day the patient undergoes the first consultation***]
2. Lead time of the treatment.
   [***The time between the first out-patient consultation and the first review after surgery***]
3. The average time a patient spends in the hospital per visit before the day of surgery.
   [***The time spent in the hospital per visit (before surgery) should be as short as possible***]
4. The average time a patient spends in hospital on the day of surgery.
   [***The time spent in the hospital on the day of surgery should be as short as possible***]

After we finished the cases studies, we reviewed the framework. We reconsidered the presence of all hypotheses and indicators based on the availability, comparability and relevance for all three cases. The findings of the review are elaborated on in the next section.

4.3 Review the framework

Some hospitals were unable to provide a number of required indicators. Although we are aware that it isn't the usual procedure, we decided to exclude four indicators prior to the analysis of the results to keep the comparison clear and to avoid comparing apples and oranges.

We excluded the following indicators to measure the ***efficiency***:

3. The average number of patients treated during one out-patient consulting hour.
   [***In order to minimize the used resources, the throughput time should be as short as possible***]
4. The average number of performed cataract surgeries per hour.
   [***In order to minimize the used resources, the throughput time should be as short as possible***]

We excluded the following indicators to measure the ***operational effectiveness***:

3. The average time a patient spends in the hospital per visit before the day of surgery.
   [***The time spent in the hospital per visit (before surgery) should be as short as possible***]
4. The average time a patient spends in hospital on the day of surgery.
   [***The time spent in the hospital on the day of surgery should be as short as possible***]

5. Introduction to the case studies

This chapter presents an introduction to the cases studies. We elaborate on the structure and content of the case chapters, the approach to collect the required information, the difficulties we faced and the differences in the used terminology.

5.1 Structure and content of the case chapters

Each chapter contains the following sections. The purpose of each section is shortly described.

- **General hospital information**
  A short introduction to the hospital. We gain insights into the background, the size, the (inter-)national position and the statistics regarding to the cataract process.
- **Flowchart of the process**
  A flowchart is a schematic diagram of the sequence of steps involved in an operation or process. It provides a visual tool that is easy to use and understand. By displaying the steps involved in an operation or process, everyone is able to develop a clear picture of how the operations works and where problems can arise (Reid and Sanders, 2002).
- **Description of the process**
  This section describes the cataract process in words. We don't focus on all the small details, but we filtered the significant elements of which we assume that are most relevant for the comparison. We are especially interested in the involved actors, their tasks and decisions. We take a closer look at the organizational design of the process and the different patient's pathways.
- **Hypotheses**
  In this section we assess the formulated hypotheses in a qualitative and in a quantitative way. We consider the important aspects of the process design and the scores on the indicators to measure the process-alignment.
- **Operational effectiveness and efficiency**
  In this section we measure the efficiency and operational effectiveness of the process by using the indicators.
- **Discussion**
  In this section we discuss the course of the case study regarding the data collection and the process description. We elaborate on the validity of the data and the impact of the national health system on the process design.

5.2 Approach

During each visit, we aimed to get familiar with the cataract process as fast as possible by observations, walk-through's and interviews with members of staff of the different units along the process. We first focused on the accomplishment of the flowchart as the flowchart isn't that time consuming to understand, and not that time consuming to be validated by the experts. After that, we modified the indicators in a way that these were especially applicable to the particular cases and we started to formulate the process description and the assessment of the hypotheses. The obtained information was processed immediately and validated by the experts to avoid misinterpretations and/or inconsistencies. As we didn't measure the indicators by ourselves, we depended on the assistance of the members of staff. In order to inform the involved employees on beforehand about the goals of the visit and the objective of the research, we sent the hypotheses, the indictors and the research framework to the hospitals two weeks prior to the visits. Although we aimed to gather all information during the visits, it was impossible. Therefore, we agreed on deadlines for forwarding the data.

The following goals were set for the visits abroad:

Goals of the case studies abroad

- Inform the involved members of staff about the goals of the visit and the objective of the research.
- Draw up a validated flowchart.
- Formulate a validated process description.
- Customize the indicators in a way that these are optimal applicable to the concerning cataract process.
- Inform the hospital about the required data.
- Agree with a contact on the deadline for forwarding the required data.
- Leave a good impression behind about the research, the author and the University of Twente.

5.3 Difficulties regarding the data collection

We faced several problems during the data collection. According to the hospitals, the required data were hard to obtain, due to the following reasons:

- Hospitals track data that are valuable for their own performance measurement. However, we were interested in data that are not used for performance measurement of the cataract process on regular basis.
- Cataract surgery is one of the most frequently executed and one of the most successful operations carried out in the world today (The foundation of the American Academy of Ophthalmology, 2008). The most commonly used procedure, the replacement of the opaque lens by an IOL, was first executed around the late sixties of last century. For almost 50 years, the used techniques and materials are refined in order to make the cataract surgery a safe and practical way to restore normal vision. Right now, there is a lot of experience and research known about the way the cataract process should be designed in order to treat the patients in the best way possible. Al kind of publications and information sharing events have resulted in great similarities between the designs of the cataract process on different continents. As we wanted to make a relevant contribution to the theory, we focused on small differences in the process designs. In order to measure those dissimilarities, we required detailed process data that was difficult to provide.

5.4 Terminology

During the case studies, we noticed some differences in the used terminology. In order to improve the comparability, we decided to use the same terminology for all case chapters.

Nursing anamnesis

The nursing anamnesis is the denominator for all tasks and examinations carried out by the nurse during the cataract process. The precise tasks and examinations may vary between the different hospitals. However, we assume that those small differences are not significant in the light of this research.

Medical clearance

The medical clearance implies that a patient underwent all pre-operative assessments and that the results were checked and approved by an internist. The patient is considered fit for cataract surgery. The term is used in The New York Eye and Ear Infirmary.

Dummy

A dummy is a sub-process that doesn't exist. It is an empty box. Dummies are used to improve the understandability of flowcharts.

Term used in thesis	Synonym / description
Anesthesiologist	Anesthetist
Blood tests	Blood works
ECG	EKG
Theatre list	Operating room schedule
Resident	Medical doctor in training
GP	General Practitioner, home doctor

Table 6; Terminology and synonyms / descriptions

6. Case study, The Rotterdam Eye Hospital

This chapter describes the results of the first case study we carried out. We used the process design and the expertise of The Rotterdam Eye Hospital to gain insights into the cataract process and to formulate the framework. The Rotterdam Eye Hospital is visited several times during the whole duration of the research.

6.1 Introduction to The Rotterdam Eye Hospital

The Rotterdam Eye Hospital is located in Rotterdam and is the only independently operating eye hospital in the Netherlands, founded in 1948. The hospital fulfills five main tasks:

- Second line ophthalmologic care for the region Rijnmond, the Netherlands.
- Third line ophthalmologic care for the Netherlands.
- Ophthalmology-training programs.
- Clinical-scientific research.
- Education for medical students.

350 employees and 26 ophthalmologists are working in the hospital. Every year, the Rotterdam Eye Hospital carries out 13.400 eye surgeries and over 140.000 out-patient consultations, of which approximately 7000 cataract surgeries. There are six operating rooms available, including two operating rooms at the Day Surgery Clinic. The day case rate is 93%. Overall, the hospital is responsible for the treatment of 8,5% of all ophthalmologic patients in the Netherlands. By integrating the eye care service through different care providers (e.g. GP's, general hospitals, optometrists, revalidation centers), The Rotterdam Eye Hospital attempts to:

- Smoothen the patient's flow through the care delivery system.
- Increase the quality of care.
- Shorten the waiting lists.

In order to maintain the quality of the five main tasks, knowledge is exchanged with the members of the American Association of Ear & Eye Hospitals and the European Association of Eye Hospitals. The Rotterdam Eye Hospital is a 'center of excellence', which implies that the delivered care in the medical, paramedical and nursing field is outstanding. In addition to delivering care, education fulfils an important role within the organization. The Rotterdam Eye Hospital facilitates education for medical student of the Erasmus University Rotterdam and ophthalmology-training programs for medical doctors from all over the country. The Rotterdam Eye Hospital maintains several national and international contacts. In cooperation with fellow hospitals and universities, The Rotterdam Eye hospital executes clinical-scientific research in order to keep improving surgeries, drug treatments and all other procedures. In addition to the first non-American admission to the American Association of Eye & Ear Hospitals in 1992, The Rotterdam Eye Hospital also participated in the establishment of the cooperation between European eye hospitals united in the European Association of Eye Hospitals (The Rotterdam Eye Hospital, 2008).

6.2 Process description

In this section we describe the organizational design of the cataract process. We use the four phases of the process to structure the description and to improve the readability.

Diagnostic phase

The cataract process starts at the Out-patient Clinic. Patients get in contact with The Rotterdam Eye Hospital as:

- They are referred to the hospital by their GP.
- They are referred to the hospital by their optometrist.
- They are referred to the hospital by another (eye-) hospital (i.e. third line referral).
- Self-referral.

Patients are seen by an ophthalmologist for the first out-patient consultation during:

- General consulting hours
- Cataract consulting hours

The out-patient consultations for patients that are under suspicion of suffering from cataract are planned during the cataract consulting hours. However, the capacity of the cataract-only consulting hours is insufficient. During this first consultation, the ophthalmologist fulfills the following tasks and decisions:

- The diagnosis cataract.
- What type of anesthetics is preferred (e.g. topical, retrobulbair or general anesthetics).
- The location for surgery (e.g. Day Surgery Clinic, a regular operating room).
- To label straightforward cataract patients.
- The decision for a paper or an ophthalmologic screening before surgery.
- What type of review after four weeks is preferred (e.g. review by an ophthalmologist, review by an optometrist).

The consulting-rooms for the general- and the cataract consulting hours are all located at the Out-patient Clinic and share the same waiting area.

Pre-operative phase

After the out-patient consultation, the patients go directly to the Pre-operative assessment Clinic to undergo the pre-operative assessments. The Pre-operative assessment Clinic is located near the Out-patient Clinic, but possesses another waiting area. First, the patients undergo a nursing anamnesis. Patients are seen according to the first comes, first served principle. The nurse assigns an ASA-score to each patient on the basis of the nursing anamnesis and the patient's medical record.

The ASA-scores are meant to support the decisions of the anesthesiologist. The Rotterdam Eye Hospital distinguishes four ASA-scores. The ASA-scores determine:

- Which pre-operative assessments are necessary.
- Which anesthetics are convenient to apply.
- Is the patient suitable for surgery in the Cataract Surgery Clinic.

The nurse provides all essential information regarding the continuation of the process and plans in discussion with the OR-planning and the patient the admission date for surgery. After the nursing anamnesis, all patients undergo a biometry. This biometry is carried out by a Technical Ophthalmic Assistant (TOA). The biometry and all other pre-operative assessments (e.g. ECG, blood tests, internist) take place in the Pre-operative assessment Clinic as well. The ECG and the blood tests are basically direct accessible. Patients that need to see the internist plan an appointment in advance and have to come back to the hospital for an extra visit. After that, the patients go home. The patient's medical record is sent to the anesthesiologist for a screening. The paper screening is carried out on the same day, but after the patient went home. The anesthesiologist decides definitely:

- What type of anesthetics is used.
- The location for surgery.
- Are additional pre-operative assessments necessary.

Officially, only the anesthesiologist is authorized to plan an appointment with the internist. However, by using strict protocols, the nurse is approved to plan the appointment during the nursing anamnesis as well. Additional pre-operative assessments always take place during an extra visit to the hospital. The hospital informs patients about those in the letter that also confirms the admission date for surgery. When the additional assessments can't take place prior to the agreed date of surgery, the surgery date is postponed.

During the first out-patient consultation at the Out-patient Clinic, the ophthalmologist labels straightforward cataract patients. Straightforward cataract patients don't need to undergo an ophthalmic screening before surgery. For these straightforward patients, only the medical record is screened about two weeks prior to the surgery (i.e. paper screening). However, the surgeon may decide after the paper screening to call the patient up for an ophthalmic screening. This additional ophthalmic screening takes place at the Out-patient Clinic during an extra visit to the hospital.

Surgical phase

Surgery takes place at two locations:

- In the Cataract Surgery Clinic
  Surgery under local anesthesia. The patient's general health is normal, the patient is mobile and proper communication is possible.
- In a regular operating room
  Surgery under general or local anesthesia. The patient's general health isn't normal, the patient isn't mobile and/or proper communication isn't possible.

On the day of surgery, patients arrive in the Day Surgery Clinic. The patient is assigned to a nurse after being dressed (i.e. surgery coat and bathrobe). The patient's eye isn't examined on the day of surgery. Surgeries under local anesthesia are supervised by an anesthesiologist or an anesthetic nurse. Surgeries under ***topical anesthesia*** are not directly supervised by an anesthesiologist. However, there is always an anesthesiologist available in the hospital. Patients that undergo surgery in a regular operating room undergo the same procedures as applies to the patients that undergo surgery in the Day Surgery Clinic.

After surgery in the Day Surgery Clinic, all patients return to the preparation area. The surgeon and the patient agree on the way the first review will be executed. After that, the patient is dismissed by the nurse. The patient's eye isn't examined on the day of surgery. The patients leaves in about 15 to 30 minutes after surgery.

The procedure for patients after surgery in the regular operating room is almost the same. However, patient that underwent general anesthesia, the normal procedure for cataract surgery in a regular operating room, are dismissed by the ophthalmologist after maximal four hours after surgery.

Post-operative phase

Depending on the surgery, the presence of pre-operative medical risks and the expectations of post-operative complications, the surgeon, the nurse, and the patient agree on which type of first review after surgery is chosen. There are three possible ways to undergo the first review after surgery:

- Review by telephone:
  - Carried out by a nurse when the patient underwent surgery in the Cataract Surgery Clinic.
  - Carried out by a resident when the patient underwent surgery in a regular operating room.
- Face-to-face review in the Out-patient Clinic. Carried out by the surgeon, or by the resident that attended the surgery.
- Self review

The Rotterdam Eye Hospital prefers to carry out the review by telephone.

During the review by telephone, the nurse or resident fill in a standard form for completion. After the anamnesis by telephone, the nurse or resident is able to conclude if:

- Everything is fine. The patient doesn't have to come to the hospital for a face-to-face review.
- The patient's condition is doubtful. The patient is instructed to come to the hospital for a face-to-face review if the complaints remain.
- There are serious complications. The patient is instructed to come to the hospital for a face-to-face review.

A face-to-face review in the hospital takes place in the Out-patient Clinic.

Patients that are qualified for self-review are instructed to contact the hospital the day after surgery if there is something wrong with their eye. Starting from that point, further action will be undertaken.

Figure 6 displays the flowchart of the process design of The Rotterdam Eye Hospital.

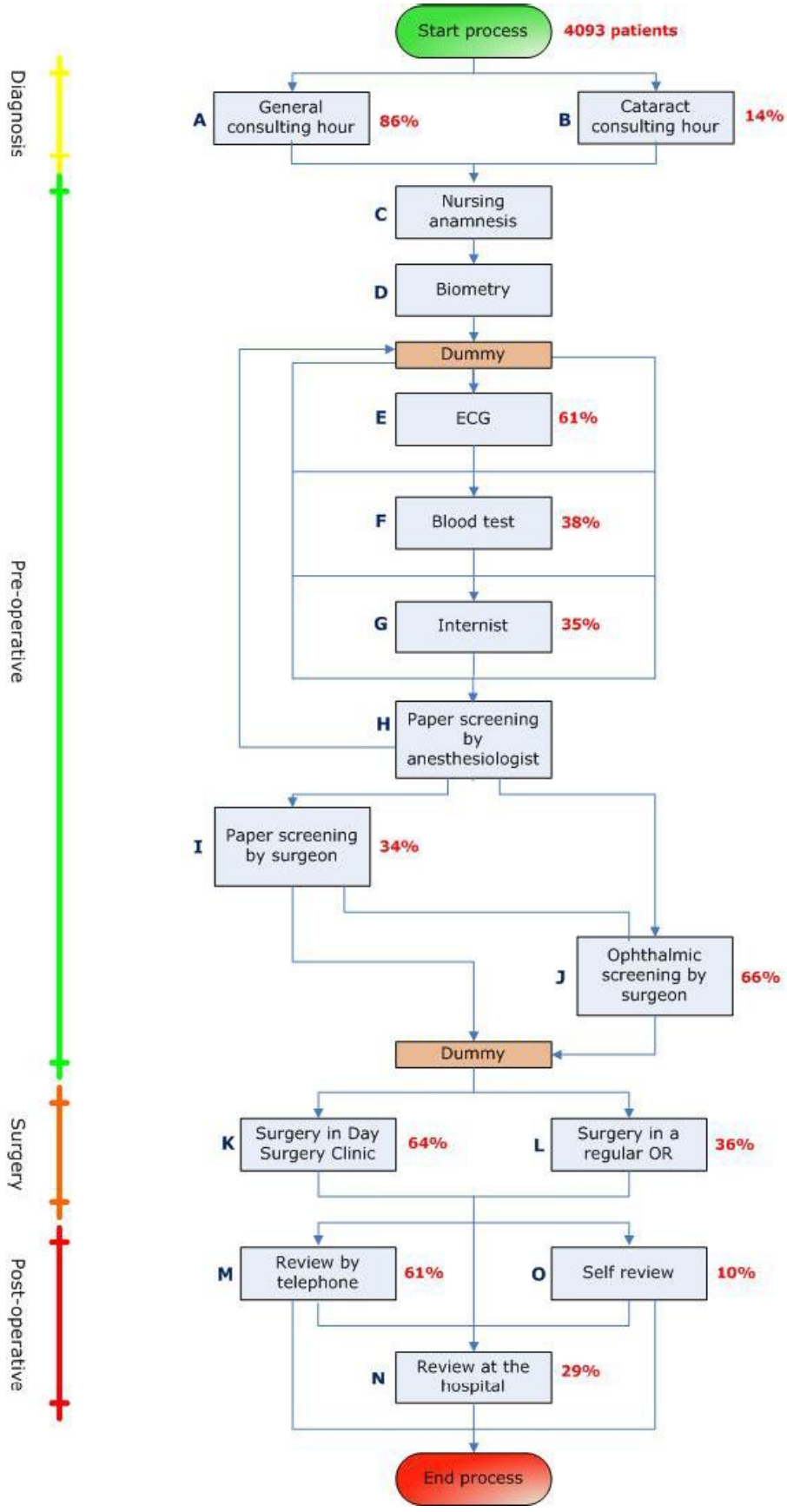


Figure 6; Current flowchart, The Rotterdam Eye Hospital

Nr	Name	# patients / year	% of all patients
A	Consultation during a general consulting hour	3513	86%
B	Consultation during a cataract consulting hour	580	14%
C	Nursing anamnesis	4093	100%
D	Biometry	4093	100%
E	ECG	2493	61%
F	Blood tests	1555	38%
G	Consultation with an internist	1449	35%
H	Paper screening by an anesthesiologist	4093	100%
I	Paper screening by surgeon	1374	34%
J	Ophthalmic screening by a surgeon	2719	66%
K	Surgery in the Cataract Surgery Clinic	2630	64%
L	Surgery in a regular operating room	1463	36%
M	First review by telephone	2497	61%
N	First review in the hospital	1187	29%
O	Self review	409	10%

Table 7; Additional data flowchart, The Rotterdam Eye Hospital

6.3 Hypothesis; to measure the process-alignment

Hypothesis 1

The process is better aligned when patients undergo the first out-patient consultation and all pre-operative assessments on the same day.

After finishing the out-patient consultation in the Out-patient Clinic, the patients go directly to the Pre-operative assessment Clinic to undergo the pre-operative assessments. The normal situation is that all patients undergo the necessary pre-operative assessments on the same day, unless:

- A patient has to see the internist. A consultation with the internist takes place during an extra visit to the hospital.
- The anesthesiologist decides after screening the patient's medical record that additional assessments are necessary. The patient has to come back for an additional visit.
- The capacities for the ECG, the blood tests or the biometry are insufficient. The Pre-operative assessment Clinic is unable to process all patients during the same day.
- Patients arrive in time to undergo the nursing anamnesis (at the end of the day). However, there isn't enough time left to undergo the other pre-operative assessments.

Numerator:	**1794**
Enumerator:	**4093**
Percentage:	**44%**

Hypothesis 2

Adjusting medical staff and/or knowledge between the diagnostic and the surgical phase avoids the redundant ophthalmic screening during the pre-operative phase, and has a positive effect upon the process-alignment.

The ophthalmologist that sees the patient during the out-patient consultation in the diagnostic phase isn't always the one that carries out the surgery. Patients undergo an ophthalmic screening before surgery when:

- The patient is a non-straightforward cataract patient. The ophthalmologist makes the decision for the ophthalmic screening during the out-patient consultation.
- The patient is a straightforward cataract patient. However, the patient requires an ophthalmic screening by the surgeon that will actually carry out the surgery (i.e. the ophthalmologist and surgeon are not the same person).
- The surgeon decides after the paper screening to call up the patient for the ophthalmic screening for one reason or other.

Numerator:	**1373**
Enumerator:	**4093**
Percentage:	**34%**

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Straightforward cataract patients are labeled during the first out-patient consultation and don't undergo:

- An ophthalmic screening before surgery.
- The face-to-face review after surgery in the hospital.
- A consultation with the internist.

Fast-track The Rotterdam Eye Hospital

Visit one: the patient undergoes the out-patient consultation and all pre-operative assessments. Visit two: the patient undergoes surgery. The first review after surgery is executed by telephone or self-review. Two visits to the hospital in total.

Numerator:	**1274**
Enumerator:	**4093**
Percentage:	**31%**

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

There are general and cataract-only consulting hours. The cataract-only consulting hours are 100% dedicated to the cataract process and the general consulting hours are not dedicated at all.

Numerator:	**580**
Enumerator:	**4093**
Percentage:	**14%**

Hypothesis 5

Planning the admission date for surgery in discussion with the patients, before they finish their pre-operative assessments and go home, has a positive effect upon the process-alignment.

The admission date for surgery is planned in discussion with the patient during the nursing anamnesis, unless:

- The anesthesiologist decides that the patient needs to undergo additional pre-operative assessments. It is impossible to plan the additional assessments before the agreed admission date. The day of surgery is postponed.
- The waiting time for surgery is longer than the planning horizon. This doesn't happen on regular basis.

Numerator:	**1846**
Enumerator:	**4093**
Percentage:	**45%**

Hypothesis 6

When members of staff are trained to execute multiple tasks during the pre-operative phase (job enlargement), the process is better aligned.

The following actors fulfill the following jobs:

- The nurse carries out the nursing anamnesis.
- A Technical Ophthalmic Assistant (TOA) carries out the biometry.
- An ECG physician executes the ECG.
- A phlebotomy physician executes the blood tests.
- The internist.
- The anesthesiologist.

There are 6 actors involved which corresponds with 0% job enlargement.

Indicator:	**0%**

Hypothesis 7

The less pre-operative assessments carried out, the higher the extent of process is aligned.

The following assessments are not required for all patients during the pre-operative phase:

- The blood tests
- An ECG
- A consultation with the internist

The assigned ASA-score determines which assessments are required. The anesthesiologist has the opportunity to require additional assessments after the paper screening.

Numerator:	**1584**
Enumerator:	**4093**
Percentage:	**39%**

Hypothesis 8

Using dedicated resources (e.g. personnel, medical technology) to execute the sub-processes in the pre-operative phase, has a positive effect upon the process-alignment.

Table 8 displays the dedication of the sub-processes in the pre-operative phase.

Pre-operative assessment	Dedicated	Percentage
Biometry	Yes	30%
Anesthesiologist	No	0%
Blood tests	No	0%
Nursing anamnesis	No	0%
ECG	No	0%
Internist	No	0%

Table 8; Dedication of the sub-processes in the pre-operative phase, The Rotterdam Eye Hospital

Indicator:	**30%**

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

All patients undergo surgery in the Cataract Surgery Clinic, unless:

- The patient needs to undergo general anesthesia. This is only available in the regular operating rooms.
- The patient isn't healthy and/or unable to lie still on a bed.
- Proper communication is impossible.

Numerator:	**2630**
Enumerator:	**4093**
Percentage:	**64%**

Hypothesis 10

Separated teaching theatre lists have a positive effect upon the process-alignment.

The Rotterdam Eye Hospital doesn't use separated teaching theatre lists.

Yes/No - indicator:	**No**

Hypothesis 11

Separated theatre lists for straightforward cataract patients have a positive effect upon the process-alignment.

The Rotterdam Eye Hospital make use of separated theatre lists for straightforward cataract patients.

Yes / No - indicator:	**Yes**

Hypothesis 12

The larger the number of patients that undergoes surgery under local anesthesia, the higher the extent of process-alignment.

The anesthesiologist determines the type of anesthetics. Surgeries under local anesthesia are preferred above surgeries under general anesthesia.

Numerator:	**3868**
Enumerator:	**4093**
Percentage:	**95%**

Hypothesis 13

Dedicated operating rooms in the Day Surgery Clinic, or using cataract-only theatre lists with dedicated personnel, has a positive effect upon the process-alignment.

The Cataract Surgery Clinic is 100% dedicated to the cataract process.

Yes/No - indicator:	**Yes**

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

The Rotterdam Eye Hospital prefers to execute the review after surgery by telephone. However, some patients are required to undergo a face-to-face review that always takes place inside the hospital. On the day of surgery, the patient's eye isn't examined.

Numerator:	**2787**
Enumerator:	**4093**
Percentage:	**68%**

Hypothesis 15

Using dedicated resources to execute the first review after surgery, has a positive effect upon the process-alignment.

The ophthalmologists that carry out the face-to-face review after surgery are not dedicated. However, as the major part of the patients (61%) is reviewed by telephone by a dedicated nurse, we state that the resources to execute the first review after surgery are dedicated.

Yes/No - indicator:	**Yes**

Hypothesis	Output	Description
1	44%	First out-patient consultation and all pre-operative assessments on the same day
2	34%	Don't underwent an additional ophthalmic screening before surgery
3	31%	Went through the fast-track
4	14%	Percentage dedicated resources to execute the first out-patient consultation
5	45%	The admission date for surgery is planned in discussion with the patient
6	0%	Percentage job enlargement in the pre-operative phase
7	39%	Underwent a minimal number of pre-operative assessments
8	30%	Percentage dedicated resources during the pre-operatives phase
9	64%	Underwent surgery in the Day Surgery Clinic
12	95%	Underwent surgery under local anesthesia
14	68%	Didn't have to come back to the hospital for the first review after surgery

Table 9; Process-alignment indicators, The Rotterdam Eye Hospital

Hypothesis	Output	Description
10	No	No separated teaching theatre lists
11	Yes	Separated theatre lists for straightforward patients
13	Yes	The Day Surgery Clinic is dedicated to the cataract process
15	Yes	The resources to execute the 1st review are dedicated to the cataract process

Table 10; Process-alignment indicators, The Rotterdam Eye Hospital

6.4 Indicators; to measure efficiency and effectiveness

Table 11 and 12 display the scores on the efficiency- and operational effectiveness indicators.

Efficiency	Output
Average # visits during treatment	3,2 visits
Total costs per treatment	139

Table 11; Scores on efficiency, The Rotterdam Eye Hospital

Operational effectiveness	Output
Access time	25 days
Lead time	66 days

Table 12; Scores on operational effectiveness, The Rotterdam Eye Hospital

Access time

The access time for the general consulting hours (86% of all patients) is: 17,5 days.

The access time for the cataract consulting hours (14% of all patients) is: 70 days.

The average access time is ≈ 25 days.

Total costs per treatment

Index number of the amount the insurance companies reimburse the hospital per cataract treatment.

6.5 Discussion

In this section we discuss the case study of The Rotterdam Eye Hospital. The Rotterdam Eye Hospital facilitated us to gain insights into the cataract process. After we finished the development of the framework, we started to carry out the case study in Rotterdam. We didn't come across many difficulties.

Process description

The following reasons facilitated the process description:

- Two students of the Erasmus University Rotterdam did research in the field of patient's satisfaction and the design of the pre-operative phase of the cataract process. They both work out a description of the cataract process.
- The Rotterdam Eye Hospital is working hard to improve their logistic processes. Several researchers doing research in the field of patient's logistics and patient's pathways. The members of staff in the hospital are familiar with researchers that are interested in the business side of the procedures. They supported us to obtain the required information.
- There is only one site where all the phases of the cataract process takes place. There are no outreach locations with other procedures and/or limited resources.
- All patients go through the same process. Patients are not separated by the way they have their health insurance arranged or by any social factors. All patients with the same medical urgency have the same priority.

Data collection

The data collection for The Rotterdam Eye Hospital was not that complicated. The hospital was able to provide the required data on time and didn't experienced many difficulties. We believe that the following reasons facilitated the data collection:

- Ellen van Vliet (research fellow operations research, The Rotterdam Eye Hospital) is involved in the performance measurement of the cataract process of The Rotterdam Eye Hospital. She was very willing to help us and has the disposal of the tools to obtain the required data.
- Ellen van Vliet was actively involved during the development of the framework. She is experienced in examining and benchmarking care delivery systems in Eye Hospitals, especially focused on the cataract process. She reconsidered all the hypotheses and indicators and specified which were supposed to be hard, easy or impossible to provide for the case hospitals.

Validity

The formulated process description and statements regarding the hypotheses are verified and approved by The Rotterdam Eye Hospital. The reliability of the data is discussed in chapter 9.

Impact on the process design by the national health system

According to the author, the impact on the organizational design of the cataract process in The Rotterdam Eye Hospital by the national health system is limited. All cataract patients have the same priority regardless to the way they have their health insurance arranged or regardless to any social factor. The health system encourages the insurance companies to trigger The Rotterdam Eye Hospital to make the delivered care more efficient (the reduce the prices) and more effective (to improve the quality). The hospital complies with those incentives by examining and improving the patient's pathways and the patient's satisfaction on regular basis. As we are unable to demonstrate examples of direct relations between the process design and the influence of the health system, we believe the impact in limited.

7. Case study, Moorfields Eye Hospital

This chapter describes the results of the second case study we carried out. We visited London for two weeks from the 5th of November until and including the 17th of November 2007.

7.1 Introduction to Moorfields Eye Hospital

Moorfields Eye Hospital, founded in 1804, is the oldest and one of the largest centers for ophthalmic treatments, teaching and research in the world. Patients in the United Kingdom prefer Moorfields Eye Hospital above other eye hospitals because of the hospital's world-famous reputation. In addition to the main site at City Road, there are another 12 outreach locations spread over greater London in order to increase the accessibility for patients. One of those 12 outreach locations is the fully dedicated Moorfields Cataract clinic, opened in 2007.

Moorfields Eye Hospital NHS
NHS Foundation Trust

Moorfields Eye Hospital offers comprehensive and seamless ophthalmic services that are internationally renowned. Every year, Moorfields Eye Hospital carries out over 23.000 ophthalmic surgeries. The admission rate is 20%. Complex ophthalmic cases (i.e. tertiary referrals) come to Moorfields Eye Hospital from across the United Kingdom and further afield. In partnership with the Institute of Ophthalmology (division of the University College London), Moorfields Eye Hospital manages the largest ongoing ophthalmic research program in the world.

Moorfields' mission is to continue as a centre of international excellence for the treatment of eye diseases and to be a leader in research and teaching. In order to achieve this mission, Moorfields Eye Hospital:

- Work to be a provider of choice for patients with eye diseases.
- Be at the leading edge of innovation in ophthalmic practice in providing new models of patient care.
- Provide an accessible and cost-effective range of high-quality ophthalmic services for patients.
- Develop and participate appropriately in a world class research strategy with the Institute of Ophthalmology and academic partners.
- Embrace employment policies which support recruitment and retention of high quality staff, recognizing their continuing goodwill as a vital resource.
- Expand the available sources of income to support our strategy while containing costs to maximize overall efficiency.
- Raise national and international awareness of the significance of eye care to the quality of people's lives and the advances made and continuing to be made in the means to meet ophthalmic needs.

Moorfields Eye Hospital is a major force in ophthalmic teaching in the United Kingdom for students, ophthalmologists and other health professionals. Medical education is an integral part of Moorfields' mission.

In Moorfields Eye Hospital work over 1300 employees on thirteen sites in and around London. Patients come to Moorfields Eye Hospital as they are referred by their GP, by an ophthalmologist or without any referral in case of an emergency. In July 2007, Moorfields Eye Hospital opened an establishment in Dubai, the United Arab Emirates. This new branch of Moorfields Eye Hospital offers a wide range of ophthalmic services to patients in the Middle East and beyond (Moorfields Eye Hospital, 2008).

7.2 Process description

Diagnostic phase

Patients get in contact with Moorfields Eye Hospital as:

- They are referred to the hospital by their GP
- They are referred to the hospital by their optometrist
- They are referred to the hospital by another (eye-) hospital (i.e. third line referral)

Patients are referred to Moorfields Eye Hospital as they suffer from cataract or from reduced eye vision. The referral letter arrives at the booking centre and is screened by a member of the clerical staff. The clerk labels patients that are under suspicion of suffering from cataract and agrees in deliberation with the patient on the treatment location. As labeling the patients is a very essential process regarding the process-alignment (i.e. patient that are referred to the Primary Care Clinic normally undergo another redundant consultation in the Cataract Clinic), all referrals are verified by a special trained nurse and/or ophthalmologist.

The two referral options to undergo the out-patient consultation are:

1. To the Primary Care Clinic. There is no indication for suffering from cataract. General consulting hours
2. To the Cataract Clinic. The patient is under suspicion of suffering from cataract. Dedicated cataract consulting hours.

Assumption, Moorfields Eye Hospital
The pathways for cataract patients at City Road and at all Outreach Clinics are the same.

In December 2007, Moorfields Eye Hospital introduced a new system called 'direct booking'. Direct booking offers GP's the opportunity to book an appointment in advance for the patient's out-patient consultation in the hospital. This implies that the clerks at the booking centre don't have to contact these patients anymore to plan their appointment as this is already done by the GP. The patient ***chooses*** a location (e.g. outreach clinic or City Road) and the GP ***books*** an appointment; choose and book.

Out-patient consultation in the Primary Care Clinic (PCC)

Patients undergo a nursing anamnesis before they are seen by an ophthalmologist. The ophthalmologist fulfills the following tasks and decisions:

- The diagnosis cataract
- The decision whether:
    - Patients are referred to the Cataract Clinic for another consultation.
    - Patients are referred directly to the Pre-operative assessment Clinic
- The type of used anesthetics.

The ophthalmologist in the Primary Care Clinic is unable to plan the admission date for surgery for patients that are directly referred to the Pre-operative assessment Clinic. For these patients, the medical record is sent to the cataract coordinator and the patient goes home. The cataract coordinator plans the admission date for surgery and for the pre-operative assessments in discussion with the patient by telephone. Patients that are referred to

the Cataract Clinic for another consultation receive their admission date for surgery after that consultation. Ophthalmologists don't plan all patients only on their own theatre lists. It depends on the patient's preferences regarding the location for surgery which surgeon will carry out the surgery. Patients that are referred for another consultation to the Cataract Clinic plan an appointment and are seen within approximately two upto eight weeks.

Out-patient consultation in the Cataract Clinic (CC)

Patients undergo a nursing anamnesis before they are seen by an ophthalmologist. The ophthalmologist fulfills the following tasks and decisions:

- Confirmation of the diagnosis cataract.
- The type of used anesthetics.
- To plan the admission date for surgery.

Afterward, the patients go directly to the Pre-operative assessments Clinic.

Pre-operative phase

The pre-operative assessments start with a nursing anamnesis. The nurse fulfills the following tasks and decisions:

- To check the patient's general health.
- To carry out several standard medical assessments (e.g. to weight the patient).
- To measure the patient's blood sugar.
- To inform the patient about the treatment.
- The biometry

ECG:	patients that are 60 years or above and/or suffering from cardiac complaints.
Blood tests:	All patients that undergo general anesthesia.

The ECG is executed by an ECG physician and the blood tests are executed by a phlebotomy physician. All pre-operative assessments take place in the same area and share the same waiting room. The nurse labels patients for a screening by an anesthesiologist. There are four scenarios for labeled patients:

- There is an anesthesiologist available. The patient is screened directly and the anesthesiologist decides whether:
    - The patients needs additional pre-op assessments.
    - The surgery is postponed.
    - The type of used anesthetics is changed (mostly from local to general anesthesia).
- There is no anesthesiologist available. The patient plans an appointment for another day.
- There is an anesthesiologist available later on that day. The patient may wait.
- There is an anesthesiologist available somewhere else in the hospital. This anesthesiologist is 'immediately' consulted.

Normally, patients undergo their out-patient consultation and the pre-operative assessments at the same location, unless:

- The patient needs additional scans that are not available at the Outreach Clinic.
- A cross check of certain results is necessary.
- There is no anesthesiologist available at the Outreach Clinic. Patients have to come for a consultation with the anesthesiologist to City Road.

Surgical and post-operative phase

Surgery takes place at two locations:

- In a regular operating room
- In the Day Surgery Clinic

Before surgery, the surgeon checks if the patient is still fit for surgery. Surgery doesn't start without supervision of an anesthesiologist. At most of the sites, the anesthesiologist is dedicated to the cataract process. After surgery, the patient stays at the ward for about one to three hours. The nurse is qualified to execute the first review directly after surgery. If there are no complications, the nurse dismisses the patient. In doubtful cases, an ophthalmologist executes the review and discharges the patient.

All patients undergo their first review after surgery on the day of surgery. The nurses that execute the first review are fully dedicated.

Table 13 displays the different sites of Moorfields Eye Hospital and the sub-processes that take place. PCC is short for Primary Care Clinic and CC is short for Cataract Clinic.

	Site	Consultation	Pre-op assessments	Surgery
1	City Road	PCC, CC	√	√
2	Bedford	-	-	-
3	Ealing	PCC, CC	√	√
4	Homerton	PCC	X	X
5	Mayday	PCC	X	X
6	Mile end	PCC, CC	√	√
7	Northwick Park	PCC, CC	√	√
8	Potters Bar	CC	√	√
9	St Ann's PCC	PCC	√	X
10	St Ann's TC	CC	√	√
11	St George's	PCC, CC	√	√
12	Upney Lane	PCC, CC	√	X
13	Watford	PCC	X	X

Table 13; All sites of Moorfields Eye Hospital

Figure 7 displays the flowchart of the process design of Moorfields Eye Hospital.

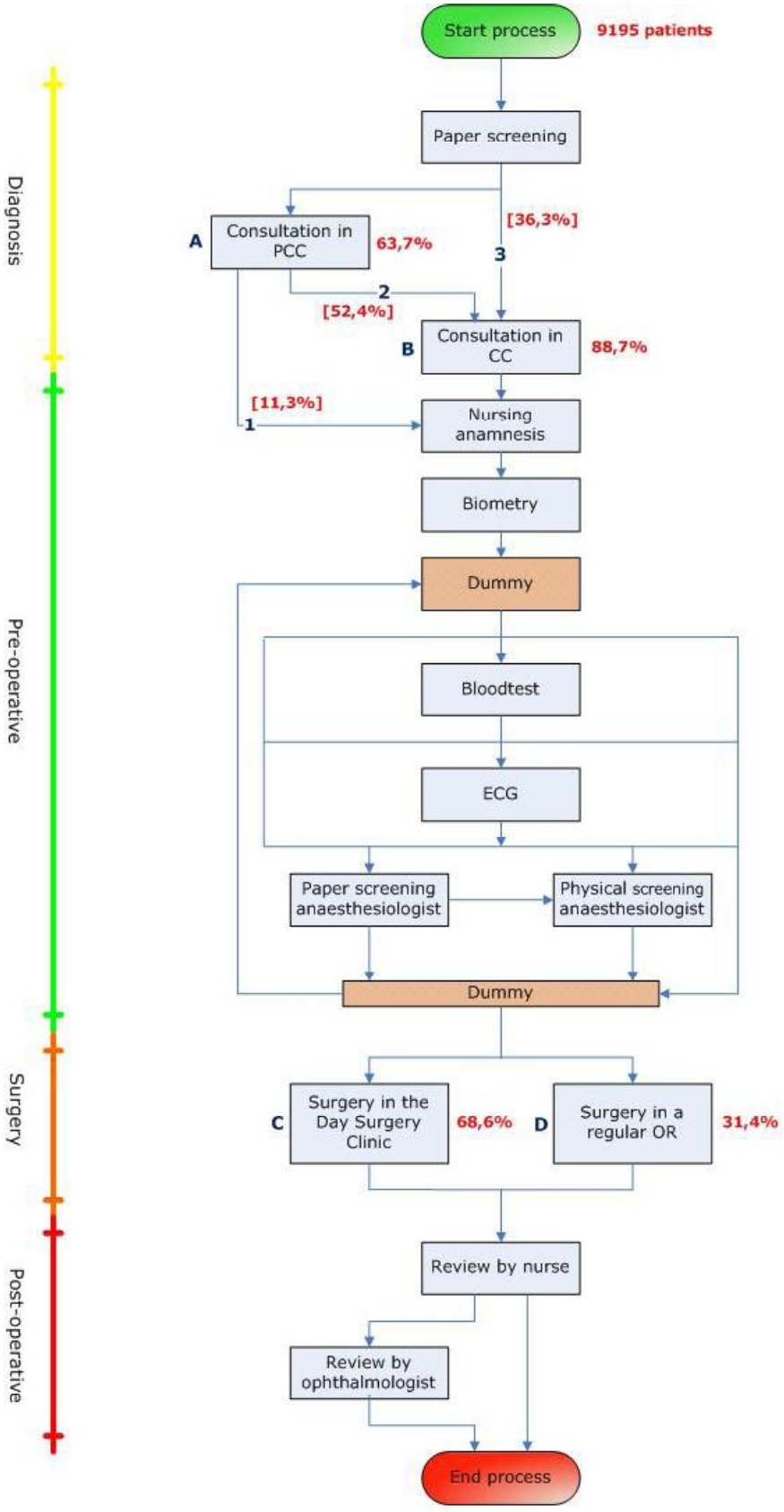


Figure 7; Current flowchart, Moorfields Eye Hospital

Nr	Name	# patients / year	% of all patients
A	Consultation in a Primary Care Clinic (PCC)	5854	63,7%
B	Consultation in a Cataract Clinic (CC)	8160	88,7%
1	Only consultation in a Primary Care Clinic	1035	11,3%
2	Consultation in a PCC and a CC	4819	52,4%
3	Only consultation in a Cataract Clinic	3341	36,3%
C	Surgery in the Day Surgery Clinic	6309	68,6%
D	Surgery in a regular operating room	2886	31,4%

Table 14; Additional data flowchart, Moorfields Eye Hospital

7.3 Hypothesis; to measure the process-alignment

Hypothesis 1

The process is better aligned when patients undergo the first out-patient consultation and all pre-operative assessments on the same day.

Cataract Clinic

After finishing the out-patient consultation in the Cataract Clinic, the patients undergo the necessary pre-operative assessments on the same day, unless:

- The patient has to see the anesthesiologist, but the anesthesiologist isn't available. The patient plans an appointment for another day.
- The anesthesiologist decides after screening the patient's medical record that additional assessments are necessary, but the patient already went home.

Primary Care Clinic

After finishing the out-patient consultation in the Primary Care Clinic, there are two scenarios:

- The patient is referred to the Cataract Clinic for another consultation. Those patients undergo the pre-operative assessments after the additional consultation in the Cataract Clinic.
- The patient isn't referred to the Cataract Clinic. Those patients go home and get contacted by the cataract coordinator to plan a date to undergo the pre-operative assessments.

Numerator:	**7356**
Enumerator:	**9195**
Ratio:	**80%**

Hypothesis 2

Adjusting medical staff and/or knowledge between the diagnostic and the surgical phase avoids the redundant ophthalmic screening during the pre-operative phase, and has a positive effect upon the process-alignment.

The ophthalmologist that sees the patient during the out-patient consultation in the diagnostic phase isn't always the one that carries out the surgery. However, the patients never undergo an additional ophthalmic screening before surgery.

Numerator:	**9195**
Enumerator:	**9195**
Ratio:	**100%**

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Straightforward cataract patients don't undergo a second redundant out-patient consultation in the diagnostic phase.

Fast-track Moorfields Eye Hospital

Visit one: the patient undergoes the out-patient consultation and all necessary pre-operative assessments on the same day. Visit two: the patient undergoes surgery and the first review after surgery. Two visits to the hospital in total.

Numerator:	**4376**
Enumerator:	**9195**
Ratio:	**38%**

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

The Cataract Clinic is 100% dedicated and the Primary Care Clinic isn't dedicated at all. We excluded the patients that undergo a consultation in the Primary Care Clinic and in the Cataract Clinic as we focus on the ***first*** out-patient consultation only.

Numerator:	**3341**
Enumerator:	**9195**
Ratio:	**36%**

Hypothesis 5

Planning the admission date for surgery in discussion with the patients, before they finish their pre-operative assessments and go home, has a positive effect upon the process-alignment.

All patients that undergo an out-patient consultation in a Cataract Clinic plan their admission date for surgery directly in discussion with the ophthalmologist. All patients that undergo only an out-patient consultation in a Primary Care Clinic are contacted at home by the cataract coordinator to plan the admission date for surgery.

Numerator:	**8160**
Enumerator:	**9195**
Ratio:	**89%**

Hypothesis 6

When members of staff are trained to execute multiple tasks during the pre-operative phase (job enlargement), the process is better aligned.

The following actors fulfill the following jobs:

- The nurse carries out the nursing anamnesis and the biometry.
- An ECG physician executes the ECG.
- A phlebotomy physician executes the blood tests.
- The anesthesiologist.

There are 4 actors involved which corresponds with 50% job enlargement.

Indicator:	**50%**

Hypothesis 7

The less pre-operative assessments carried out, the higher the extent of process is aligned.

The following assessments are not required for all patients during the pre-operative phase:

- The blood tests
- An ECG
- A paper screening by the anesthesiologist
- A consultation with the internist

Blood tests are required for all patients that undergo general anesthesia. The ECG is required for all 60+ patients and/or patients that are suffering from cardiac complaints. The nurse qualifies patients that need to be screened by an anesthesiologist. The anesthesiologist has the opportunity to require additional assessments.

Numerator:	**7356**
Enumerator:	**9195**
Ratio:	**20%**

Hypothesis 8

Using dedicated resources (e.g. personnel, medical technology) to execute the sub-processes in the pre-operative phase, has a positive effect upon the process-alignment.

Table 15 displays the dedication of the sub-processes in the pre-operative phase.

Pre-operative assessment	Dedicated	Percentage
Biometry	No	0%
Anesthesiologist	No	0%
Blood tests	No	0%
Nursing anamnesis	No	0%
ECG	No	0%

Table 15; Dedication of the sub-processes in the pre-operative phase, Moorfields Eye Hospital

Indicator:	**0%**

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

All patients undergo surgery in the Day Surgery Clinic, unless:

- The patient needs to undergo general anesthesia. This is only available in the regular operating rooms.
- The patient isn't healthy and/or unable to lie still on a bed.
- Proper communication is impossible.

Numerator:	**6309**
Enumerator:	**9195**
Percentage:	**69%**

Hypothesis 10

Separated teaching theatre lists have a positive effect upon the process-alignment.

Moorfields Eye Hospital doesn't use separated teaching theatre lists.

Yes/No - indicator:	**No**

Hypothesis 11

Separated theatre lists for straightforward cataract patients have a positive effect upon the process-alignment.

Moorfields Eye Hospital make use of separated theatre lists for straightforward cataract patients.

Yes/No - indicator:	**Yes**

Hypothesis 12

The larger the number of patients that undergoes surgery under local anesthesia, the higher the extent of process-alignment.

The anesthesiologist determines the type of anesthetics. Surgeries under local anesthesia are preferred above surgeries under general anesthesia.

Numerator:	**8735**
Enumerator:	**9195**
Percentage:	**96%**

Hypothesis 13

Dedicated operating rooms in the Day Surgery Clinic, or using cataract-only theatre lists with dedicated personnel, has a positive effect upon the process-alignment.

The Day Surgery Clinic is 100% dedicated to the cataract process.

Yes/No - indicator:	**Yes**

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

All patients are reviewed directly after surgery by a nurse or an ophthalmologist. No patients have to come to the hospital for the first review after surgery.

Numerator:	**9195**
Enumerator:	**9195**
Ratio:	**100%**

Hypothesis 15

Using dedicated resources to execute the first review after surgery, has a positive effect upon the process-alignment.

The nurse and the ophthalmologist that carry out the first review after surgery are dedicated to the cataract process.

Yes/No - indicator:	**Yes**

Hypothesis	Output	Description
1	80%	First out-patient consultation and all pre-operative assessments on the same day
2	100%	Don't underwent an additional ophthalmic screening before surgery
3	38%	Went through the fast-track
4	36%	Percentage dedicated resources to execute the first out-patient consultation
5	89%	The admission date for surgery is planned in discussion with the patient
6	50%	Percentage job enlargement in the pre-operative phase
7	20%	Underwent a minimal number of pre-operative assessments
8	0%	Percentage dedicated resources during the pre-operatives phase
9	69%	Underwent surgery in the Day Surgery Clinic
12	96%	Underwent surgery under local anesthesia
14	100%	Didn't have to come back to the hospital for the first review after surgery

Table 16; Process-alignment indicators, Moorfields Eye Hospital

Hypothesis	Output	Description
10	No	No separated teaching theatre lists
11	Yes	Separated theatre lists for straightforward patients
13	Yes	The Day Surgery Clinic is dedicated to the cataract process
15	Yes	The resources to execute the 1st review are dedicated to the cataract process

Table 17; Process-alignment indicators, Moorfields Eye Hospital

7.4 Indicators; to measure efficiency and effectiveness

Table 18 and 19 display the scores on the efficiency- and operational effectiveness indicators.

Efficiency	Output
Average # visits during treatment	3 visits
Total costs per treatment	31

Table 18; Scores on efficiency, Moorfields Eye Hospital

Operational effectiveness	Output
Access time	31,5 days
Lead time	77,7 days

Table 19; Scores on operational effectiveness, Moorfields Eye Hospital

Total costs per treatment

Index number of the amount the insurance companies reimburse the hospital per cataract treatment.

7.5 Discussion

In this section we discuss the case study of Moorfields Eye Hospital. Moorfields Eye Hospital was the first case study we carried out abroad. It was the first time we faced the applicability of the framework in an unknown care delivery system. The major difficulty we dealt with were the twelve outreach locations. Most of the outreach locations operated in a different way, dealing with different resources and procedures. We decided to consider the hospital as one case and we took the main location, City Road, as the leading site.

Process description

The following remarks concern the formulation of the process description of Moorfields Eye Hospital:

- Not all outreach locations have the disposal of the same equipment and therefore the ability to carry out the entire treatment. There is variation in the procedures and the assignment of duties in the process. We made consensus to formulate one process-description.
- All patients go through the same process at each location. Patients are not separated by the way they have their health insurance arranged or by any social factors. All patients with the same medical urgency have the same priority.
- Moorfields Cataract Clinic is a fully dedicated outreach location. We assume that Moorfields Cataract Clinic has a positive effect upon the process-alignment. Therefore, it was difficult to balance to what extent we had to take this outreach location into account without interfering with the reliability of the comparison.

Data collection

The data collection for Moorfields Eye Hospital came across many difficulties. Our contact left Moorfields Eye Hospital before the required data was provided. The new contact needed additional time to get familiar with our project. Eventually, Moorfields Eye Hospital was unable to supply the information concerning:

- The number of patients that undergo an ECG.
- The number of patients that undergo blood tests.
- The number of patients that undergo a consultation with the anesthesiologist.
- The number of patients that are screened by the anesthesiologist.

Validity

The formulated process description and statements regarding the hypotheses are verified and approved by Moorfields Eye Hospital. The reliability of the data is discussed in chapter 9.

Impact on the process design by the national health system

We noticed an impact on the organizational design of the cataract process by the national health system in Moorfields Eye Hospital. The Department of Health requires hospitals to reduce the access time and lead time of the cataract process to a maximum of 18 weeks. However, Moorfields Eye Hospital scored worst on both indicators (e.g. access time, lead time) in comparison to the other two hospitals. In our opinion, the 18 weeks clock (Department of Health, 2006) is a reflection of the focus we observed in Moorfields Eye Hospital on reducing the access and lead time. Moorfields Eye hospital reported us that the target for 2008/2009 is to reduce the access time to 19,6 days and to reduce the lead time to 49 days.

8. Case study, The New York Eye and Ear Infirmary

This chapter describes the results of the third case study we carried out. We visited New York for one week and a half from the 3rd of December until and including the 14th of December 2007.

8.1 Introduction to The New York Eye and Ear Infirmary

The origin of The New York Eye and Ear Infirmary dates to 1816, when two young graduates of the New York College of Physicians and Surgeons set out from New York to continue their medical training in London. In London, they were introduced to the London Infirmary for Curing Diseases of the Eye, later famed as the Royal London Ophthalmic Hospital (Moorfields Eye Hospital).

After returning to the USA, The New York Eye and Ear Infirmary was founded in 1820, to meet the eye care needs of the New Yorkers. The New York Eye and Ear Infirmary is the oldest specialty hospital in Western Hemisphere. In 1999, the infirmary became a member of the Continuum Health Partners, which implies that the hospital is a voluntary, non-profit specialty hospital providing comprehensive out-patient and state-of-the-art surgical care in the disciplines of Ophthalmology, Otolaryngology (Head & Neck Surgery), and Plastic & Reconstructive Surgery. The New York Eye and Ear Infirmary's out-patient ophthalmology and otolaryngology programs provide primary care and treatments in those specialties for New York City, but also for the regional, national and international communities with unique tertiary surgical specialty services in their fields of expertise. With approximately 142,000 out-patient visits and over 20,000 eye surgical procedures per year, The New York Eye and Ear Infirmary is the largest provider of eye care in The United Stated of America.

In compliance with the mission of providing high quality patient care, community outreach, graduate and continuing medical education and scientific research, The New York Eye and Ear Infirmary has built upon its strengths to emerge as a recognized leader in the fields of eye, ear, nose and throat care. The ophthalmology and otolaryngology departments regularly rank among the highest for all hospitals throughout the United States of America. The New York Eye and Ear Infirmary is also a market leader in plastic and reconstructive surgical procedures in the New York metropolitan area. The New York Eye and Ear Infirmary currently has over 40 contracts with Health Maintenance Organizations (HMO's) and Preferred Provider Organizations (PPO's), and maintains strong relationships with a vast number of primary care physicians in the tri-state region.

The New York Eye and Ear Infirmary is the primary teaching center of the prestigious New York Medical College and affiliated teaching hospitals in these specialty areas. Each year, more than 20 residents and fellows are graduated, making it one of the finest training programs for ophthalmologists and otolaryngologists in the world today (The New York Eye and Ear Infirmary, 2008).

8.2 Process description

The New York Eye and Ear Infirmary distinguishes two different types of patients, based on the way they get in contact with the hospital:

- Private patients
- Clinic patients

As there is a relevant difference in the process design of both patient's pathways, we take the separation into account during the whole study.

Private patients
Private patients are referred by an outside physician to come to The New York Eye and Ear Infirmary to be treated for services.

Clinic patients
Clinic patients come to the Eye Clinic to be seen for services. They are normally not referred by any physician but rather show up for these services as a walk-in patient. Clinic patients are also called ***Service*** or ***Teaching patients.***

Only clinic patients are qualified to go through all phases of the cataract process ***inside*** the hospital. Private patients are sometimes excluded as they are out of control of the hospital.

Diagnostic phase

Private patients

Private patients are referred to the ophthalmologist by their:

- GP / internist
- Insurance company
- Self referral

200 self-employed ophthalmologists are authorized to schedule their surgeries in The New York Eye & Ear Infirmary. The out-patient consultations for those private patients take place ***outside*** the hospital. The outside surgeons get block times assigned to use the operating rooms. A block time is defined as:

Block time
A series of successive hours one operating room is assigned to one ophthalmologists to plan his/her surgeries.

The length and number of block times assigned to an ophthalmologist is determined by a special committee of the New York Eye and Ear Infirmary. The ophthalmologists schedule their block times by themselves according to their own preferences. The surgeons decide whether a patient undergo surgery in a regular operating room or in the Day Surgery Clinic (cases under general anesthesia always take place in a regular operating room).

During the out-patient consultation, the ophthalmologist fulfills the following tasks and decisions:

- Examination of the eye.
- Biometry
- The diagnosis cataract.
- The type of used anesthetics.
- The location for surgery (e.g. the Day Surgery Clinic, a regular operating room)
- Same-day-testing or pre-operative-testing

After the consultation, the admission date for surgery is planned. The pre-operative assessments take place at two locations, depending on the patient's preferences:

- In The New York Eye and Ear Infirmary.
- In a Primary Care Centre ***outside*** the hospital.

Clinic patients

Clinic patients are self-referred to the hospital. All clinic patients undergo their first out-patient consultation with a resident in the Eye Clinic.

Resident

A medical doctor that works and lives in the hospital in order to become an ophthalmologist within approximately two years.

During the consultation with the resident, the resident fulfills the following tasks and decisions:

- Examination of the eye.
- Biometry.
- The diagnosis cataract.
- The type of used anesthetics.
- The location for surgery (e.g. the Day Surgery Clinic, a regular operating room)

The decisions made by the residents are verified and confirmed by an attending ophthalmologist.

After the out-patient consultation, the admission date for surgery and for the pre-operative assessments are planned. The pre-operative assessments take place at two locations, depending on the patient's insurance company:

- In The New York Eye and Ear Infirmary.
- In a Primary Care Centre ***outside*** the hospital.

After the appointments are planned, the patient goes home. The Eye Clinic isn't dedicated to the cataract process.

Pre-operative phase

As already mentioned before, private and clinic patients decide to undergo the pre-operative assessments ***outside*** or ***inside*** the hospital. There are three different pathways for patients to finish the pre-operative assessments:

Same day testing, available for private patients only.

Patients undergo the pre-operative assessments and surgery on the same day ***inside*** the hospital. An anesthesiologist screens the patient's medical record 48 hours prior to the surgery. On the day of surgery, the patient undergoes the nursing anamnesis and the nurse determines which pre-operative assessments are necessary. Afterwards, all patients undergo successively the pre-operative assessments, a consultation with an internist to receive the medical clearance, and a consultation with an anesthesiologist. The anesthesiologist decides when additional assessments are necessary. After that, the patient is ready for surgery.

Pre-operative-testing, available for private and clinic patients.

Patients undergo the pre-operative assessments between 1 day and 1 month prior to the day of surgery. An anesthesiologist screens the patient's medical record 48 hours prior to the day the pre-operative assessments take place. On the assessment day, the patient undergoes the nursing anamnesis and the nurse determines which pre-operative assessments are necessary. The patients undergo these pre-operative assessments and receive a medical clearance after a consultation with an internist. Subsequently, all patients go home and return on the day of surgery.

Outside pre-operative-testing, available for private and clinic patients

Patients undergo the pre-operative assessments and receive the medical clearance ***outside*** hospital. 72 hours prior to the day of surgery, the patient send the results of the pre-operative assessments and the medical clearance to the hospital. An anesthesiologist screens the patient's medical record 48 hours prior to the surgery and decides if additional assessments are necessary. The patients undergo additional assessments on the day of surgery. On the day of surgery, all patients undergo a consultation with an internist and an anesthesiologist. The consultation with the internist and the additional assessments inside the hospital are redundant for patients that are pre-operative tested ***outside*** the hospital.

The Pre-admission testing area isn't dedicated to the cataract process. The ECG and blood tests are both executed by the same technician. The internists are assisted by physician assistants. There is always an anesthesiologist available at the Pre-admission testing area that sees patients according to the first comes, first served principle.

ECG:	40 years or above.
Blood tests:	Patients that undergo general anesthesia

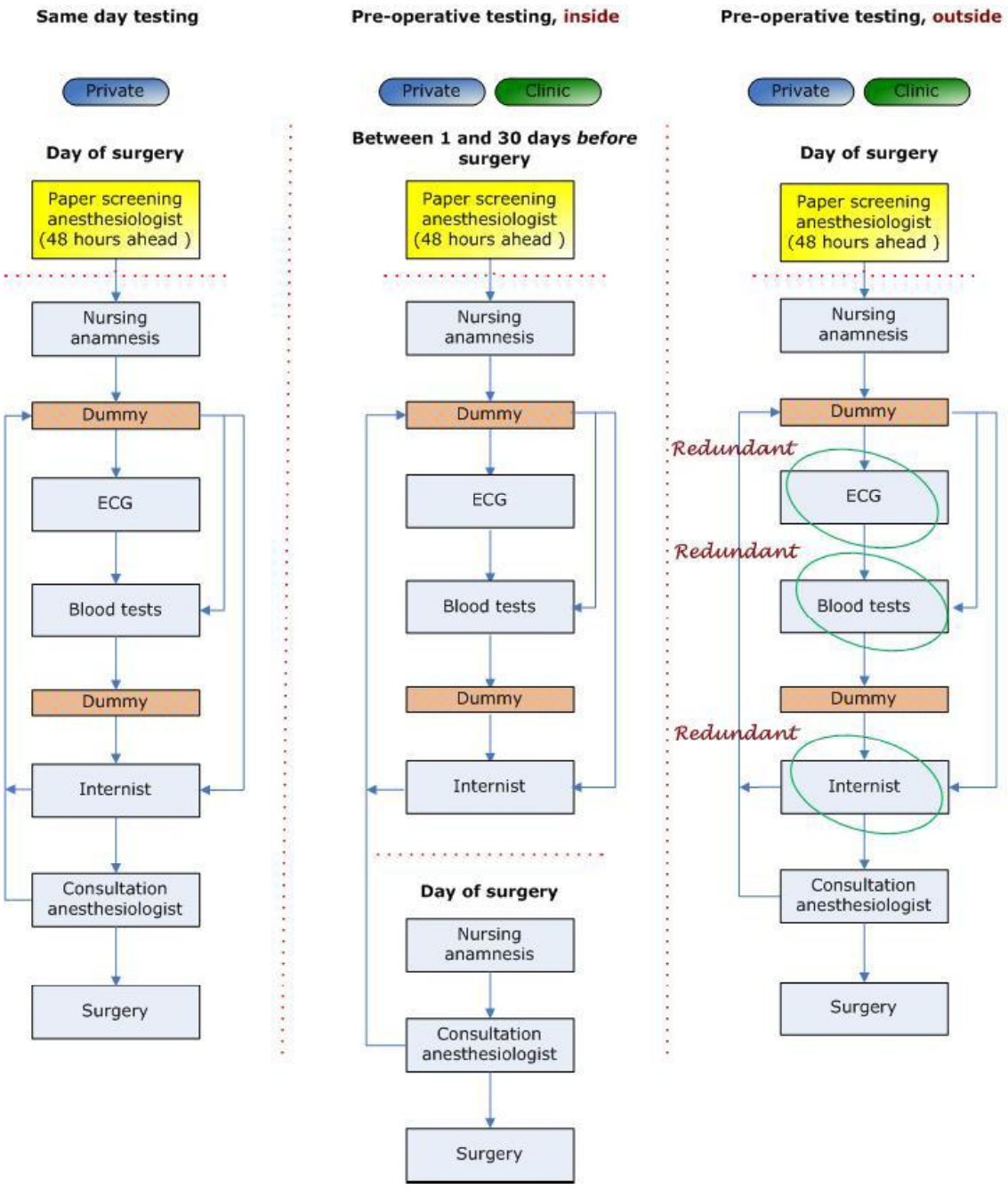


Figure 8; Pre-operative pathways, the New York Eye and Ear Infirmary

Surgical phase

Surgery takes place for private and clinic patients at two locations:

- In a regular operating room
- In the Day Surgery Clinic

On the day of surgery, all patients undergo a short nursing anamnesis. The patients that underwent the pre-operative assessments ***outside*** the hospital undergo a consultation with the internist. The internist decides when additional assessments are necessary. After that, all patients undergo a consultation with an anesthesiologist. The internist and the anesthesiologist are not dedicated to the cataract process and see patients according to the first comes, first served principle.

The location for surgery depends on the preferences of the surgeon and the scheduled block times. All cases under general anesthesia take place in a regular operating room.

The New York Eye & Ear Infirmary makes use for of three different types of anesthetics:

- General anesthetics. Only available in the regular operating rooms. An anesthesiologist or an anesthetic nurse (CRNA: Certified Registered Nurse in Anesthesia) supervises the patient during surgery. There is always an anesthesiologist standing-by somewhere else in the hospital.
- Local anesthetics (i.e. retrobulbar injection). An anesthesiologist or a CRNA supervises the patient during surgery. There is always an anesthesiologist standing-by somewhere else in the hospital.
- Monitored Anesthetics Care (MAC). MAC is local anesthesia plus sedation. An anesthesiologist or an CRNA supervise the patient during surgery. There is always an anesthesiologist standing-by somewhere else in the hospital.

The surgeons give the retro-bulbar injections in the operating room.

After surgery, the patients go to the B-section of the pre-admission testing area. After about 15 minutes, they are seen by a nurse who checks the patient's general health. The eye isn't examined on the day of surgery. The nurse is qualified to dismiss the patient or ask an anesthesiologist for assistance to make the final decision.

Post-operative phase

One day after surgery, all patient undergo a face-to-face review with their surgeon (e.g. resident or ophthalmologist) in the Eye Clinic for clinic patients or ***outside*** the hospital for private patients

Figure 9 displays the flowchart of the process design of The New York Eye and Ear Infirmary.

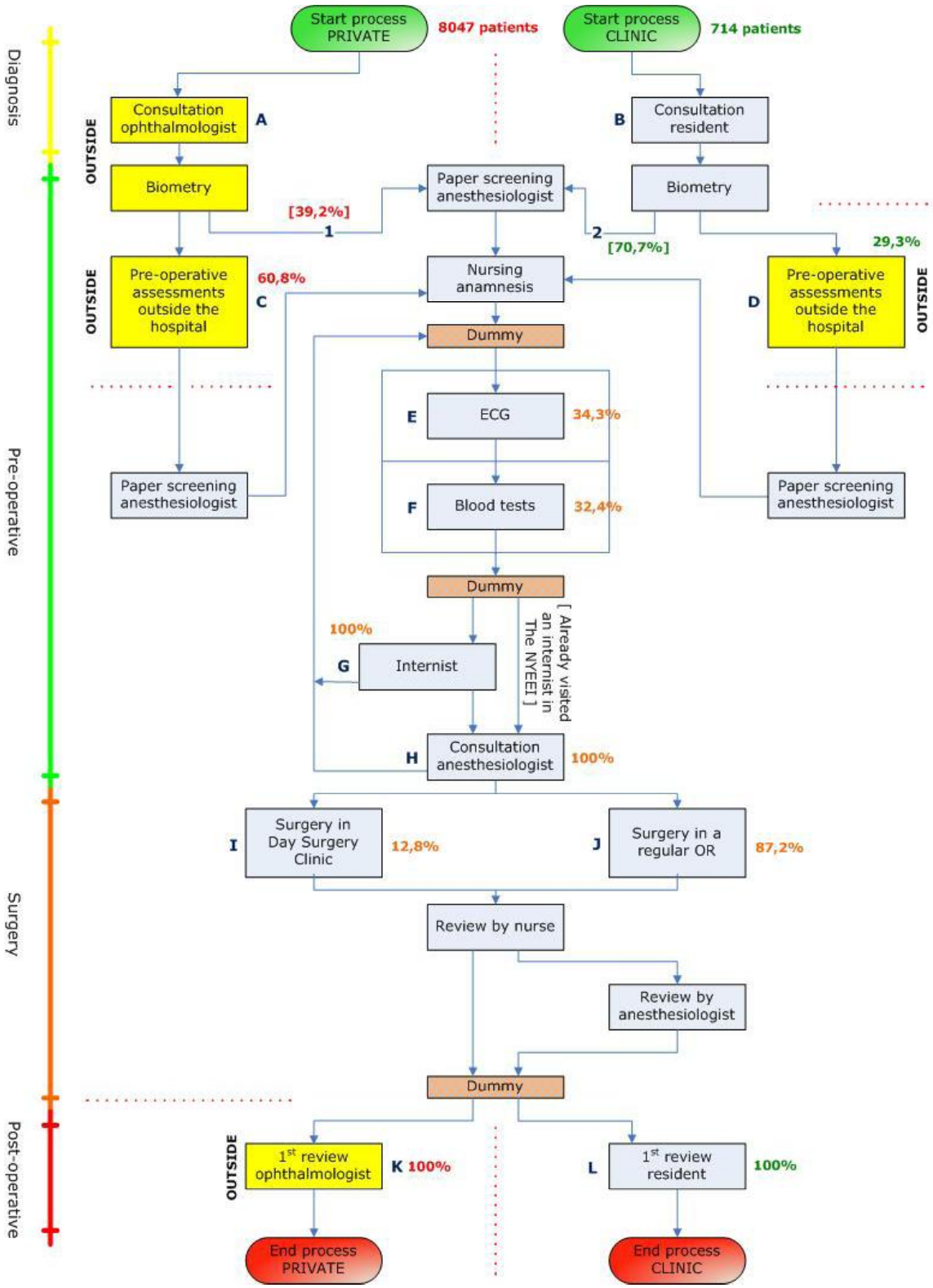


Figure 9; Current flowchart, The New York Eye and Ear Infirmary

Nr	Name	# patients / year	% of all patients
A	First out-patient consultation ***outside*** the hospital	8047	91,9%
B	First out-patient in the Eye Clinic of The NYEEI	714	8,1%
C	Private patients; pre-operative assessments ***outside*** the hospital	4890	55,8%
D	Clinic patients; pre-operative assessments ***outside*** the hospital	209	2,4%
C+D	All patients; pre-operative assessments ***outside*** the hospital	5099	58,2%
1	Private patients; pre-operative assessments inside The NYEEI	505	5,8%
2	Clinic patients; pre-operative assessments inside The NYEEI	2948	33,6%
1+2	All patients; pre-operative assessments inside The NYEEI	3453	39,4%
E	ECG	3004	34,3%
F	Blood tests	2839	32,4%
G	Consultation with an internist	8047	100%
H	Consultation with an anesthesiologist	8761	100%
I	Surgery in the Day Surgery Clinic	7637	87,2%
J	Surgery in a regular operating room	1124	12,8%
K	First review ***outside*** the hospital	8047	91,9%
L	First review inside The NYEEI	714	8,1%

Table 20; Additional data flowchart, The New York Eye and Ear Infirmary

8.3 Hypothesis; to measure the process-alignment

Hypothesis 1

The process is better aligned when patients undergo the first out-patient consultation and all pre-operative assessments on the same day.

There are three possible patient's pathways:

- The patient undergoes the out-patient consultation ***outside*** the hospital (i.e. private patients)
- The patient undergoes the out-patient consultation ***inside*** the hospital, but chooses to undergo the pre-operative assessment ***outside*** the hospital (i.e. in their own Primary Care Center)
- The patient undergoes the out-patient consultation and the pre-operative assessments ***inside*** the hospital. These patients plan a date to undergo the pre-operative assessments after the out-patient consultation.

No patients undergo the first out-patient consultation and all pre-operative assessments on the same day ***inside*** the hospital. We excluded the private patients as they are out of control of the hospital. Therefore, we use the total number of clinic patients as enumerator instead of all cataract patients.

Numerator:	**0**
Enumerator:	**714 (all clinic patients)**
Ratio:	**0%**

Hypothesis 2

Adjusting medical staff and/or knowledge between the diagnostic and the surgical phase avoids the redundant ophthalmic screening during the pre-operative phase, and has a positive effect upon the process-alignment.

All residents and ophthalmologists plan their patients only on their own theatre lists. Therefore, the ophthalmic screenings never takes place.

Numerator:	**8761**
Enumerator:	**8761**
Ratio:	**100%**

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

The New York Eye and Ear Infirmary doesn't label straightforward cataract patients. For that reason, all patients go through the same sub-processes. However, The New York Eye and Ear Infirmary offers private patients the opportunity to undergo ***'same day testing'***. This implies that these patients combine their pre-operative assessments and their surgery in one visit. Since this procedure saves a visit to the hospital, we assume that patients that undergo 'same day testing' go through the fast-track.

Fast-track The New York Eye and Ear Infirmary

Patients that undergo same day testing during the pre-operative phase.

Numerator:	**2523**
Enumerator:	**8761**
Ratio:	**29%**

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

The Eye Clinic isn't dedicated to the cataract process. All consultations take place during general consulting hours. We excluded the private patients as they are out of control of the hospital. Therefore, we use the total number of clinic patients as enumerator.

Numerator:	**0**
Enumerator:	**714**
Ratio:	**0%**

Hypothesis 5

Planning the admission date for surgery in discussion with the patients, before they finish their pre-operative assessments and go home, has a positive effect upon the process-alignment.

There are two scenarios possible:

- All clinic patients get their admission date for surgery directly after the out-patient consultation.
- All private patients get their admission date for surgery ***outside*** the hospital.

We excluded the private patients as they are out of control of the hospital. Therefore, we use the total number of clinic patients as enumerator.

Numerator:	**714**
Enumerator:	**714**
Ratio:	**100%**

Hypothesis 6

When members of staff are trained to execute multiple tasks during the pre-operative phase (job enlargement), the process is better aligned.

The following actors fulfill the following jobs:

- The nurse carries out the nursing anamnesis.
- An technician executes the ECG and blood tests.
- The internist.
- The anesthesiologist.
- The ophthalmologist carries out the biometry.

There are 5 actors involved which corresponds with 25% job enlargement.

Indicator:	**25%**

Hypothesis 7

The less pre-operative assessments carried out, the higher the extent of process is aligned.

The following assessments are not required for all patients during the pre-operative phase:

- The blood tests
- An ECG

The blood tests are required for all patients that undergo general anesthesia. The ECG is required for all 40+ patients and/or patients that are suffering from cardiac complaints. The anesthesiologist and the internist anesthesiologist have the opportunity to require additional assessments.

Numerator:	**0**
Enumerator:	**8761**
Ratio:	**0%**

Hypothesis 8

Using dedicated resources (e.g. personnel, medical technology) to execute the sub-processes in the pre-operative phase, has a positive effect upon the process-alignment.

Table 21 displays the dedication of the sub-processes in the pre-operative phase.

Pre-operative assessment	Dedicated	Percentage
Biometry	No	0%
Anesthesiologist	No	0%
Blood tests	No	0%
Nursing anamnesis	No	0%
ECG	No	0%
Internist	No	0%

Table 21; Dedication of the sub-processes in the pre-operative phase, The New York Eye and Ear Infirmary

Indicator:	**0%**

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

The location for surgery depends on the preferences of the surgeon and the availability of the block times. Therefore, it may happen that patients that are eligible for surgery in the Day Surgery Clinic undergo surgery in a regular operating room. Surgeries under general anesthesia always take place in a regular operating room.

Numerator:	**7366**
Enumerator:	**8761**
Percentage:	**84%**

Hypothesis 10

Separated teaching theatre lists have a positive effect upon the process-alignment.

The New York Eye and Ear Infirmary uses separated teaching theatre lists.

Yes/No - indicator:	**Yes**

Hypothesis 11

Separated theatre lists for straightforward cataract patients have a positive effect upon the process-alignment.

Surgeons draw up their own theatre lists. The New York Eye and Ear Infirmary doesn't use of separated theatre lists for straightforward cataract patients.

Yes/No - indicator:	**No**

Hypothesis 12

The larger the number of patients that undergoes surgery under local anesthesia, the higher the extent of process-alignment.

The anesthesiologist determines the type of anesthetics. Surgeries under local anesthesia are preferred above surgeries under general anesthesia.

Numerator:	**8551**
Enumerator:	**8761**
Percentage:	**98%**

Hypothesis 13

Dedicated operating rooms in the Day Surgery Clinic, or using cataract-only theatre lists with dedicated personnel, has a positive effect upon the process-alignment.

The Day Surgery Clinic isn't dedicated to the cataract process and there are no cataract-only theatre lists.

Yes/No - indicator:	**No**

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

All patients are required to undergo a face-to-face review after surgery. This review takes place one day after surgery in the Eye Clinic for clinic patients or ***outside*** the hospital for private patients. On the day of surgery, the patient's eye isn't examined.

Numerator:	**0**
Enumerator:	**8761**
Ratio:	**0%**

Hypothesis 15

Using dedicated resources to execute the first review after surgery, has a positive effect upon the process-alignment.

We excluded the private patients as they are out of control of the hospital. The review after surgery for clinic patients take place in the Eye Clinic which isn't dedicated to the cataract process.

Yes/No - indicator:	**No**

Hypothesis	Output	Description
1	0%	First out-patient consultation and all pre-operative assessments on the same day
2	100%	Don't underwent an additional ophthalmic screening before surgery
3	29%	Went through the fast-track
4	0%	Percentage dedicated resources to execute the first out-patient consultation
5	100%	The admission date for surgery is planned in discussion with the patient
6	25%	Percentage job enlargement in the pre-operative phase
7	0%	Underwent a minimal number of pre-operative assessments
8	0%	Percentage dedicated resources during the pre-operatives phase
9	84%	Underwent surgery in the Day Surgery Clinic
12	98%	Underwent surgery under local anesthesia
14	0%	Didn't have to come back to the hospital for the first review after surgery

Table 22; Process-alignment indicators, The New York Eye and Ear Infirmary

Hypothesis	Output	Description
10	Yes	There are separated teaching theatre lists
11	No	No separated theatre lists for straightforward patients
13	No	The Day Surgery Clinic isn't dedicated to the cataract process
15	No	The resources to execute the 1st review are not dedicated to the cataract process

Table 23; Process-alignment indicators, The New York Eye and Ear Infirmary

8.4 Indicators; to measure efficiency and effectiveness

Table 24 and 25 display the scores on the efficiency- and operational effectiveness indicators.

Indicator efficiency	Output
Average # visits during treatment	3,6 visits
Total costs per treatment	131

Table 24; Scores on efficiency, The New York Eye and Ear Infirmary

Indicator – Effectiveness	Output
Access time	0 days (for clinic patients)
Lead time	15 days

Table 25; Scores on operational effectiveness, The New York Eye and Ear Infirmary

Average number of visits

We excluded the patients that undergo the pre-operative assessments ***outside*** the hospital as they are out of control of the hospital. 2523 patients undergo ´same day testing' and visit the hospital 3 times. 3662 patients undergo pre-operative testing and visit the hospital 4 times. The average number of visits to the hospital for all patients is 3,6 visits.

Total costs per treatment

Index number of the amount the insurance companies reimburse the hospital per cataract treatment.

8.5 Discussion

In this section we discuss the case study of The New York Eye and Ear Infirmary. The New York Eye and Ear Infirmary was the third and last case study we carried out. The major difficulty we faced was the distinction between private and clinic patients. Both groups deal with dissimilar restrictions and privileges during the process. The main deficiency of the cataract process in the light of our research was that some patients undergo important sub-processes ***outside*** the hospital, which were excluded from the research. Only 6% of all patients underwent all phases of the process ***inside*** the hospital.

Process description

The following remarks concern the formulation of the process description of the New York Eye and Ear Infirmary:

- Some patients undergo sub-processes ***outside*** the hospital. Although these parts were excluded, we had to be familiar with the available options and keep the case comparable.
- There is only one site where all the phases of the cataract process takes place. There are no outreach locations with other procedures and/or limited resources.

Data collection

The data collection for The New York Eye and Ear Infirmary was not that complicated. The hospital was able to provide the required data on time and didn't experienced many difficulties.

Validity

The formulated process description and statements regarding the hypotheses are verified and approved by The New York Eye and Ear Infirmary. The reliability of the data is discussed in chapter 9.

Impact on the process design by the national health system

We noticed an impact on the organizational design of the cataract process by the national health system in The New York Eye and Ear Infirmary. An example is the separation into private and clinic patients. Both groups face their own restrictions and privileges that influenced the organizational design of the cataract process. Patients don't always have the same priority. For example: only private patients are qualified to undergo the same-day-testing procedure.

Another aspect that affects the organizational design of the process, is the fear for lawsuits. "The fear of getting sued leads an alarming number of doctors to practice defensive medicine, such as ordering unnecessary tests and avoiding risky procedures, a survey of 824 Pennsylvania doctors found" (The MSNBC, 2005). This seems to happen in The New York Eye and Ear Infirmary as well. An ophthalmologist admitted that he was aware of redundant procedures for cataract patients. However, the fear for lawsuits may decide him to act different in certain situation. The most explicit example is the consultation with the internist. Patients that underwent their pre-operative assessments ***outside*** the hospital, get their medical clearance ***outside*** the hospital as well. This medical clearance is provided by an internist and implies that the patient is ready for cataract surgery. However, all patients are required to undergo another consultation with an internist ***inside*** The New York Eye and Ear Infirmary, just to be safe from the juridical point of view.

9. Analysis results

In section 9.1, we discuss the relevance of the hypotheses and corresponding indicators by examining the scores of the hospitals, the reliability of the scores and the observed process-alignment during the case studies. For each hypothesis, we answer the question: ***'Do the differences in the scores of the hospitals correspond with the differences in the observed extent of process-alignment?'.*** This answer tell us if the formulated hypotheses are appropriate tools to measure the extent of process-alignment of cataract processes. Each hypothesis is accepted or rejected within the framework of this research. Scores that we assume not correctly measured, are labeled unreliable. Unreliable scores may still be used to assess the relevance of the hypotheses, but are not used to demonstrate an association.

In section 9.2, we examine if the extent of process-alignment is positively associated with the efficiency and/or operational effectiveness of the cataract process for all accepted hypotheses. First, we consider the reliability of the efficiency and operational effectiveness indicators. We use the results of this chapter to propose recommendations in chapter 10.

Rotterdam is short for: The Rotterdam Eye Hospital
London is short for: Moorfields Eye Hospital
New York is short for: The New York Eye and Ear Infirmary

9.1 Relevance hypotheses

Hypothesis 1
The process is better aligned when patients undergo the first out-patient consultation and all pre-operative assessments on the same day.

Indicator 1: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that undergo the first out-patient consultation and all necessary pre-operative assessments on the same day ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year***.

UNRELIABLE

Rotterdam: **44%**	London: **80%**	New York: **0%**

The output of this indicator is affected by the organizational design of the diagnostic and pre-operative phase. We observe large differences in the scores, especially between Moorfields Eye Hospital and The New York Eye and Ear Infirmary. The score of The New York Eye and Ear Infirmary ***should*** correspond to the lowest extent of process-alignment. We examine if that is a representive reflection of the current situation. In The New York Eye and Ear Infirmary, only clinic patients are qualified to undergo the first out-patient consultation and all pre-operative assessments on the same day ***inside*** the hospital. All private patients undergo the out-patient consultation ***outside*** the hospital. As clinic patients account for only 8,1% of all cataract patients, we assume the New York Ear and Eye Infirmary doesn't aim to align the diagnostic and the pre-operative phases. For that reason, we believe that the 0% score is reliable and corresponds to the current extent of process-alignment.

The score scored by Moorfields Eye Hospital is relatively high. Patients that undergo only a consultation in the Primary Care Clinic, don't undergo their pre-operative assessments on the same day on regular basis. Furthermore, the referral from the Primary Care Clinic to Cataract Clinic doesn't take place on the same day as well. For those reasons, ***we consider the 80% score of Moorfields Eye Hospital not reliable***. However, since 36,3% of all patient is referred directly to the Cataract Clinic and patients from the Cataract Clinic undergo the pre-operative assessments on the same day, we suppose that a realistic score ***should*** be at least 36,3%. Taking the later observation into account, we assume that the hypothesis and the corresponding indicator are relevant tools to measure the process-alignment of a cataract process. Therefore, we accept the hypothesis.

ACCEPTED

Hypothesis 2
Adjusting medical staff and/or knowledge between the diagnostic and the surgical phase avoids the redundant ophthalmic screening during the pre-operative phase, and has a positive effect upon the process-alignment.

Indicator 2: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that don't undergo an ophthalmic screening before surgery ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

Rotterdam: **34%**	London: **100%**	New York: **100%**

According to the scores, the process design of Moorfields Eye Hospital and The New York Eye and Ear Infirmary ***should*** correspond to the maximal extent of process-alignment. The Rotterdam Eye Hospital is the only hospital that qualifies patients to undergo an ophthalmic screening by an ophthalmologist in the pre-operative phase. Since the process design of Moorfields Eye Hospital and The New York Eye and Ear Infirmary doesn't include ophthalmic screenings for all patients, we consider the scores reliable and correspond with our observations. Therefore we accept the hypothesis.

ACCEPTED

Hypothesis 3
Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Indicator 3: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that go through the fast-track ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

Rotterdam: **31%**	London: **38%**	New York: **29%**

The output of this indicator is affected by the organizational design of all phases of the cataract process. The variation in the scores is limited. The scores are based on our definition of the hospital's fast-tracks. All scores are considered reliable. We accept this hypothesis as an appropriate tool to measure the process-alignment of a cataract process.

ACCEPTED

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

Indicator 4: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]

Numerator:

The number of operated cataract patients that underwent the first out-patient consultation during a cataract-only consulting hour ***per year.***

Denominator:

The total number of cataract patients that undergo cataract surgery ***per year.***

Rotterdam: **14%**	London: **36%**	New York: **0%**

The lowest score is scored by The New York Eye and Ear Infirmary. This score ***should*** correspond to the minimal extent of process-alignment. The score is caused by the non-dedicated Eye Clinic where the out-patient consultations take place. In The New York Eye and Ear Infirmary, only clinic patients undergo their out-patient consultation ***inside*** the hospital. We suppose that The New York Eye and Ear Infirmary doesn't have the intention to assign dedicated resources to the diagnostic phase for clinic patients only. For that reason, we believe that the 0% score is reliable and corresponds to the current extent of process-alignment. The scores of Moorfields Eye Hospital and The Rotterdam Eye Hospital correspond with our observations a well. We believe that the dedicated Cataract Clinics of Moorfields Eye Hospital have a positive effect upon the process-alignment. Therefore, we accept the hypothesis.

ACCEPTED

Hypothesis 5

Planning the admission date for surgery in discussion with the patients, before they finish their pre-operative assessments and go home, has a positive effect upon the process-alignment.

Indicator 5: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]

Numerator:

The number of cataract patients that get an admission date for surgery during the pre-operative phase before they go home ***per year.***

Denominator:

The total number of cataract patients that undergo cataract surgery ***per year.***

Rotterdam: **45%**	London: **89%**	New York: **100%**

The highest score is scored by The New York Eye and Ear Infirmary. This score ***should*** correspond to the highest extent of process-alignment. In The New York Eye and Ear Infirmary, only clinic patients receive their admission date for surgery ***inside*** the hospital. However, these patients account for only 8,1% of all patients. Private patients are excluded since they are out of the control of the hospital. We consider all scores reliable and correspond with our observations. Therefore, we accept this hypothesis as an appropriate tool to measure the process-alignment.

ACCEPTED

Hypothesis 6
When members of staff are trained to execute multiple tasks during the pre-operative phase (job enlargement), the process is better aligned.

Indicator 6: [Percentage; a ***higher*** percentage corresponds with ***higher*** extent of process-alignment]
The percentage job enlargement during the pre-operative phase [min 0%, max 100%]

Rotterdam: **0%**	London: **50%**	New York: **25%**

The score of The Rotterdam Eye Hospital ***should*** correspond with the lowest extent of process-alignment. If we compare the process design of The Rotterdam Eye Hospital and The New York Eye and Ear Infirmary, we assume that the differences in the scores don't correspond with the differences in the extent of process-alignment. On the other hand, job enlargement in the pre-operative phase of Moorfields Eye has a positive effect upon the process-alignment. However, based on the differences in the scores and the reliability of the indicator, we don't consider this hypothesis and indicator as appropriate tools to measure the process-alignment of a cataract process.

REJECTED

Hypothesis 7
The less pre-operative assessments carried out, the higher the extent of process is aligned.

Indicator 7: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that haven't undergone any pre-operative assessments except the biometry and the nursing anamnesis ***per year.***
Denominator:
The total number of cataract patients that undergo cataract surgery ***per year.***

Rotterdam: **39%**	London: **20%**	New York: **0%**

Based on the case studies, we ***expected*** the highest output scored by Moorfields Eye Hospital since we consider their process design to be the best aligned. This isn't the case. On the other hand, the output of The New York Eye and Ear Infirmary corresponds with the lowest extent of process-alignment as we expected. The misleading position of Moorfields Eye Hospital is caused by the exclusion of Moorfields patients that received an ECG. Therefore, although the scores are reliable, we don't consider this hypothesis and indicator as appropriate tools to measure the extent of process alignment of a cataract process.

REJECTED

Hypothesis 8
Using dedicated resources (e.g. personnel, medical technology) to execute the sub-processes in the pre-operative phase, has a positive effect upon the process-alignment.

Indicator 8: [Percentage; a ***higher*** percentage corresponds with ***higher*** extent of process-alignment]
The percentage dedicated resources used during the pre-operative phase of the cataract process.
[min 0%, max 100%]

UNRELIABLE

Rotterdam: **30%**	London: **0%**	New York: **0%**

Both Moorfields Eye Hospital and The New York Eye and Ear Infirmary score the lowest score. As there are no dedicated resources assigned to the pre-operative phase in The New York Eye and Ear Infirmary, we believe that the score is reliable and corresponds with our observations. The score of Moorfields Eye Hospital is misleading. Moorfields Cataract Clinic ***should*** score 100% since it is a fully dedicated cataract outreach location. However, since we take all Moorfield's sites into account, this score becomes unreliable for the comparison. Nevertheless, we consider this hypothesis as an appropriate tool to measure the extent of process-alignment.

ACCEPTED

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

Indicator 9: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]

Numerator:

The number of cataract patients that undergo surgery in the Day Surgery Clinic ***per year.***

Denominator:

The total number of cataract patients that undergo cataract surgery ***per year.***

Rotterdam: **64%**	London: **69%**	New York: **84%**

There isn't much variation in the scores of the hospitals and all scores are considered reliable. The scores don't oppose our expectations based on the case studies. We consider this hypothesis as an appropriate tool to measure the process-alignment of a cataract process. Therefore, we accept the hypothesis.

ACCEPTED

Hypothesis 10

Separated teaching theatre lists have a positive effect upon the process-alignment.

Indicator 10: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]

No; there are no separated teaching theatre lists for cataract surgery.

Yes; there are separated teaching theatre lists for cataract surgery.

UNRELIABLE UNRELIABLE

Rotterdam: **No**	London: **No**	New York: **Yes**

Our hypothesis states that separated teaching theatre lists have a positive effect upon the process-alignment. The New York Eye and Ear Infirmary is the only hospital that makes use of those separated theatre lists. However, it was difficult to assess this hypothesis by a Yes/No – indicator. For example, not all teaching sessions were always separated. The same applies to Moorfields Eye Hospital. For that reason, those scores are considered unreliable. We believe that separated teaching theatre lists have a positive effect upon the process-alignment. However, due to the combination of the unreliable scores and the used indicator, we reject this hypothesis.

REJECTED

Hypothesis 11
Separated theatre lists for straightforward cataract patients have a positive effect upon the process-alignment.

Indicator 11: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]
No; there are no separated theatre lists for straightforward cataract patients.
Yes; there are separated theatre lists for straightforward cataract patients.

UNRELIABLE

Rotterdam: **Yes**	London: **Yes**	New York: **No**

The Rotterdam Eye Hospital and Moorfields Eye Hospital make use of separated theatre lists for straightforward cataract patients. However, similar to what we discussed for hypothesis 10, it is difficult to assess this hypothesis by a Yes/No – indicator. Therefore, the score of The New York Eye and Ear Infirmary is considered unreliable. We believe that separated theatre lists for straightforward cataract patients have a positive effect upon the process-alignment. However, due to the combination of the unreliable scores and the used indicator, we reject this hypothesis.

REJECTED

Hypothesis 12
The larger the number of patients that undergoes surgery under local anesthesia, the higher the extent of process-alignment.

Indicator 12: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]
Numerator:
The number of cataract patients that undergo local anesthesia ***per year.***
Denominator:
The total number of cataract patients that undergo surgery ***per year.***

Rotterdam: **95%**	London: **96%**	New York: **98%**

There isn't much variation in the scores of the hospitals. The scores of the hospitals are all considered reliable. We believe that this hypothesis is an appropriate tool to measure the process-alignment of a cataract process. Therefore, we accept this hypothesis.

ACCEPTED

Hypothesis 13
Dedicated operating rooms in the Day Surgery Clinic, or using cataract-only theatre lists with dedicated personnel, has a positive effect upon the process-alignment.

Indicator 13: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]
No; there are no dedicated operating rooms in the Day Surgery Clinic or the hospital don't use cataract-only theatre lists.
Yes; there are dedicated operating rooms in the Day Surgery Clinic or the hospital use cataract-only theatre lists.

Rotterdam: **Yes**	London: **Yes**	New York: **No**

The New York Eye and Ear Infirmary is the only hospital which scores 'no' on the indicator. 'No' ***should*** correspond to a lower extent of process-alignment in comparison with the other two hospitals. In contrast with hypotheses 10 and 11, assessing the process design concerning this hypothesis was possible by using a Yes/No – indicator. The scores are therefore considered reliable. We believe that the extent of process-alignment in The New York Eye and Ear Infirmary is lower as they don't make use of dedicated operating rooms. This hypothesis is therefore considered as an appropriate tool to measure the extent of process-alignment of a cataract process.

ACCEPTED

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

Indicator 14: [Numerator/Denominator; a ***higher*** score corresponds with ***higher*** extent of process-alignment]

Numerator:

The number of cataract patients that don't come back to the hospital for the first review after surgery ***per year.***

Denominator:

The total number of cataract patients that undergo cataract surgery ***per year.***

Rotterdam**: 68%**	London: **100%**	New York: **0%**

We observe large differences in the scores, especially between Moorfields Eye Hospital and The New York Eye and Ear Infirmary. The score of Moorfields Eye Hospital ***should*** correspond to the highest extent of process alignment and The New York Eye and Ear Infirmary ***should*** correspond to the lowest extent. We believe that the process design of Moorfields Eye Hospital is best aligned and the process design of The New York Eye and Ear Infirmary is worst aligned. Therefore, we consider the scores reliable and we accept this hypothesis.

ACCEPTED

Hypothesis 15

Using dedicated resources to execute the first review after surgery, has a positive effect upon the process-alignment.

Indicator 15: [Yes/No - indicator; ***Yes*** corresponds with ***higher*** extent of process-alignment]

No; there are no dedicated resources assigned to execute the first review after surgery.

Yes; there are dedicated resources assigned to execute the first review after surgery.

UNRELIABLE UNRELIABLE

Rotterdam: **Yes**	London: **Yes**	New York: **No**

Similar to what we discussed for hypothesis 10 and 11, it is difficult to assess this hypothesis by a Yes/No–indicator as the dedication of the resources depends on the way the review is executed and on the location. Therefore, we consider the scores of The Rotterdam Eye Hospital and Moorfields Eye Hospital unreliable. We believe that assigned dedicated resources to execute the first review after surgery has a positive effect upon the process-alignment. However, due to the combination of the unreliable scores and the used indicator, we reject this hypothesis.

REJECTED

	Relevant	
Hypothesis **1**		**Yes**
Hypothesis **2**		**Yes**
Hypothesis **3**		**Yes**
Hypothesis **4**		**Yes**
Hypothesis **5**		**Yes**
Hypothesis **6**	**No**	
Hypothesis **7**	**No**	
Hypothesis **8**		**Yes**
Hypothesis **9**		**Yes**
Hypothesis **10**	**No**	
Hypothesis **11**	**No**	
Hypothesis **13**		**Yes**
Hypothesis **13**		**Yes**
Hypothesis **14**		**Yes**
Hypothesis **15**	**No**	

Table 26; Relevance of the hypotheses

9.2 Association with efficiency and/or operational effectiveness

In this section we examine the possible association between process-alignment and the efficiency and/or operational effectiveness of the cataract process. For each hypothesis, we answer the question: ***'Do the differences in the extent of process-alignment of the hospitals correspond with the differences in the efficiency and/or operational effectiveness of the cataract process?'.*** We only assess the hypotheses which are considered as appropriate tools to measure the extent of process-alignment in section 9.1. We omit hypotheses with unreliable scores on the indicators. First, we examine the reliability of the efficiency- and operational effectiveness indicators. We reject indicators that are considered unreliable.

9.2.1 Efficiency and operational effectiveness indicators

Efficiency indicator	Rotterdam	London	New York
Average # of visits to the hospital during the treatment	3,2	3,0	3,6

There isn't much variation in the scores of the hospitals. We consider the scores on this indicator reliable and therefore we accept the indicator. A ***lower*** score corresponds with ***higher*** efficiency.

Efficiency indicator	Rotterdam	London	New York
Total costs per treatment	139	31	131

The total costs per treatment in Moorfields Eye Hospital are significant lower in comparison to The Rotterdam Eye Hospital and The New York Eye and Ear Infirmary. Since Moorfields Eye Hospital didn't provided one amount for the total costs per treatment, we believe that this score is unreliable. We are unable to replace this amount by an estimation. For that reason, we don't to take this indicator into account.

REJECTED

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days

We observe that there is no access time in The New York Eye and Ear Infirmary for clinic patients. Private patients are excluded as they start their cataract process ***outside*** the hospital. Since we took this separation into account for the hypotheses as well, we believe that the scores on this indicator are reliable. Therefore, we accept this indicator. A ***lower*** score corresponds with ***higher*** efficiency.

Operational effectiveness indicator	Rotterdam	London	New York
Lead time	66 days	77,7 days	15 days

The lead time for clinic patients in The New York Eye and Ear Infirmary is the shortest in comparison to the other hospitals. The private patients are again excluded from this indicator. We believe that the scores are reliable. Therefore we accept this indicator. A ***lower*** score corresponds with ***higher*** efficiency.

We use the following indicators for efficiency and operational effectiveness to demonstrate an association with the process-alignment of the cataract process:

- The average number of visits to the hospital during the treatment.
- The access time to start the treatment.
- The lead time of the treatment.

9.2.2 Association between process-alignment, efficiency and operational effectiveness

Hypothesis 1
The process is better aligned when patients undergo the first out-patient consultation and all pre-operative assessments on the same day.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **1**	44%	80%	0%

As mentioned in section 9.1, we consider the score of Moorfields Eye Hospital unreliable. Therefore, we are unable to demonstrate an association between this hypothesis and the efficiency of the cataract process.

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **1**	44%	80%	0%

As mentioned in section 9.1, we consider the score of Moorfields Eye Hospital unreliable. Therefore, we are unable to demonstrate an association between this hypothesis and the operational effectiveness of the cataract process.

Hypothesis 2

Adjusting medical staff and/or knowledge between the diagnostic and the surgical phase avoids the redundant ophthalmic screening during the pre-operative phase, and has a positive effect upon the process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **2**	34%	100%	100%

The two best aligned process designs match with the most and least efficient cataract processes. The differences in the extent of process-alignment don't correspond with the differences in the efficiency. For that reason, we are unable to demonstrate a positive association between hypothesis 2 and the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **2**	34%	100%	100%

The most and least operational effective cataract processes correspond with two best aligned process designs. For that reason, we are unable to demonstrate a positive association between hypothesis 2 and the operational effectiveness of the cataract process.

OPERATIONAL EFFECTIVENESS

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **3**	31%	38%	29%

The process design of Moorfields Eye Hospital is the best aligned and the most efficient. The process design of The New York Eye and Ear Infirmary is the worst aligned and least efficient. The differences in the extent of process-alignment correspond with the differences in the efficiency, which implies that hypothesis 3 is positively associated with the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **3**	31%	38%	29%

The process design of Moorfields Eye hospital is the best aligned, but the least operational effective according to both indicators. However, conform the operational effectiveness, the process design of The New York Eye and Ear Infirmary ***should*** correspond with the highest extent of process alignment in order prove positive association. However, The New York Eye and Ear Infirmary matches with the lowest extent of process-alignment. Therefore, we believe that hypothesis 3 isn't associated with the operational effectiveness of the cataract process.

OPERATIONAL EFFECTIVENESS

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **4**	14%	36%	0%

The process design of Moorfields Eye Hospital is the best aligned and the most efficient. The process design of The New York Eye and Ear Infirmary is the worst aligned and least efficient. The differences in the extent of process-alignment correspond with the differences in the efficiency, which implies that hypothesis 4 is positively associated with the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **4**	14%	36%	0%

The process design of Moorfields Eye hospital is the best aligned, but the least effective according to both indicators. However, conform the measured operational effectiveness, the process design of The New York Eye and Ear Infirmary ***should*** correspond with the highest extent of process alignment in order demonstrate positive association. Therefore, we believe that hypothesis 4 isn't associated with the operational effectiveness of the cataract process.

OPERATIONAL EFFECTIVENESS

Hypothesis 5

Planning the admission date for surgery in discussion with the patients, before they finish their pre-operative assessments and go home, has a positive effect upon the process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **5**	45%	89%	100%

The New York Eye and Ear Infirmary is the least efficient, but the process-design is the best aligned. The lowest extent of process-alignment is measured in The Rotterdam Eye Hospital. However, The Rotterdam Eye Hospital isn't the least efficient. Therefore, we believe that hypothesis 5 isn't associated with the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **5**	45%	89%	100%

The New York Eye and Ear Infirmary is the most operational effective and the process design is the best aligned. This implies positive association. However, the difference in the extent of process-alignment between Moorfields Eye Hospital and The New York Eye and Ear Infirmary doesn't correspond with the difference in the efficiency. Therefore, we don't believe that hypothesis 5 is associated with the operational effectiveness. Otherwise, we would expect a higher level of operational effectiveness at Moorfields Eye Hospital. For those reasons, we are unable to demonstrate an association.

OPERATIONAL EFFECTIVENESS

Hypothesis 8

Using dedicated resources (e.g. personnel, medical technology) to execute the sub-processes in the pre-operative phase, has a positive effect upon the process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **8**	30%	0%	0%

As mentioned in section 9.1, we consider the score of Moorfields Eye Hospital unreliable. Therefore, we are unable to demonstrate an association between this hypothesis and the efficiency of the cataract process.

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **8**	30%	0%	0%

As mentioned in section 9.1, we consider the score of Moorfields Eye Hospital unreliable. Therefore, we are unable to demonstrate an association between this hypothesis and the operational effectiveness of the cataract process.

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **9**	64%	69%	84%

The New York Eye and Ear Infirmary is the least efficient, but the process-design is the best aligned. The lowest extent of process-alignment is measured in The Rotterdam Eye Hospital. However, The Rotterdam Eye Hospital isn't the least efficient. We believe that hypothesis 9 isn't associated with the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **9**	64%	69%	84%

The New York Eye and Ear Infirmary is the most operational effective and the best aligned. This suggests positive association. Furthermore, there isn't much variation between the extent of process-alignment and the operational effectiveness in The Rotterdam Eye Hospital and Moorfields Eye Hospital. The relative difference between the extent of process-alignment of The New York Eye and Ear Infirmary and the other two hospitals corresponds with the same difference regarding the operational effectiveness. For that reason, we believe that hypothesis 9 is positively associated with operational effectiveness.

OPERATIONAL EFFECTIVENESS

Hypothesis 12

The larger the number of patients that undergoes surgery under local anesthesia, the higher the extent of process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **12**	95%	96%	98%

The differences between the extent of process-alignment of the three hospitals are considered insignificant small. We believe that the differences are caused by differences in the population mix and therefore not related to the process design. For that reason, we are unable to demonstrate an association between this hypothesis and the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **12**	95%	96%	98%

The differences between the extent of process-alignment of the three hospitals are considered insignificant small. We believe that the differences are caused by differences in the population mix and therefore not related to the process design. For that reason, we are unable to demonstrate an association between this hypothesis and the operational effectiveness of the cataract process.

OPERATIONAL EFFECTIVENESS

Hypothesis 13

Dedicated operating rooms in the Day Surgery Clinic, or using cataract-only theatre lists with dedicated personnel, has a positive effect upon the process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **13**	Yes	Yes	No

In spite of what the scores suggest. We believe, as all cataract surgeries are day cases, that we can't justify an association between the extent of process-alignment and the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **13**	Yes	Yes	No

The two best aligned hospitals are the least operational effective. The worst aligned hospital is the most operational effective. This suggests a negative association between using dedicated operating rooms in the Day Surgery Clinic and the operational effectiveness. However, we believe that we can't justify an association between the extent of process-alignment and the operational effectiveness of the cataract process.

OPERATIONAL EFFECTIVENESS

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

Efficiency indicator	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Hypothesis **14**	68%	100%	0%

The process design of Moorfields Eye hospital is the best aligned and the most efficient. The process design of The New York Eye and Ear Infirmary is the worst aligned and the least efficient. This implies positive association between the extent of process- alignment and the efficiency of the cataract process.

EFFICIENCY

Operational effectiveness indicator	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis **14**	68%	100%	0%

The process design of Moorfields Eye hospital is the best aligned, but the least operational effective according to both indicators. However, conform the measured operational effectiveness, the process design of The New York Eye and Ear Infirmary ***should*** correspond with the highest extent of process alignment in order demonstrate positive association. Therefore, we believe that hypothesis 14 isn't associated with the operational effectiveness of the cataract process.

OPERATIONAL EFFECTIVENESS

		Efficiency		Operational effectiveness	
Hypothesis **1**	**Unreliable**				
Hypothesis **2**		**No**		**No**	
Hypothesis **3**			**Yes**	**No**	
Hypothesis **4**			**Yes**	**No**	
Hypothesis **5**		**No**		**No**	
Hypothesis **8**	**Unreliable**				
Hypothesis **9**		**No**			**Yes**
Hypothesis **12**		**No**		**No**	
Hypothesis **13**		**No**		**No**	
Hypothesis **14**			**Yes**	**No**	

Table 27; Hypotheses associated with efficiency and/or operational effectiveness

To increase the ***efficiency***, we propose recommendations to increase the process-alignment regarding the following hypotheses as these are positively associated with efficiency:

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

To increase the ***operational effectiveness***, we propose recommendations to increase the process-alignment regarding the following hypotheses as these are positively associated with operational effectiveness:

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

Hypotheses and efficiency	Rotterdam	London	New York
Average # visits during the treatment	3,2	3	3,6
Total cost per treatment	139	31	131
Hypothesis 1	44%	80%	0%
Hypothesis 2	34%	100%	100%
Hypothesis 3	31%	38%	29%
Hypothesis 4	14%	36%	0%
Hypothesis 5	45%	89%	100%
Hypothesis 8	30%	0%	0%
Hypothesis 9	64%	69%	84%
Hypothesis 12	95%	96%	98%
Hypothesis 13	Yes	Yes	No
Hypothesis 14	68%	100%	0%

Table 28; Scores on the hypotheses and efficiency indicators, all cases

Hypotheses and operational effectiveness	Rotterdam	London	New York
Access time	25 days	31,5 days	0 days
Lead time	66 days	77,7 days	15 days
Hypothesis 1	44%	80%	0%
Hypothesis 2	34%	100%	100%
Hypothesis 3	31%	38%	29%
Hypothesis 4	14%	36%	0%
Hypothesis 5	45%	89%	100%
Hypothesis 8	30%	0%	0%
Hypothesis 9	64%	69%	84%
Hypothesis 12	95%	96%	98%
Hypothesis 13	Yes	Yes	No
Hypothesis 14	68%	100%	0%

Table 29; Scores on the hypotheses and operational effectiveness indicators, all cases

10. Recommendations

In this section we propose recommendations for the hospitals to improve the process-alignment. We elaborate on the hypotheses that are positively associated with efficiency and/or operational effectiveness.

10.1 Recommendations for The Rotterdam Eye Hospital

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **3**	**31**%	38,1%	29%

The output of this indicator is affected by the organizational design of all phases of the cataract process. We recall our definition of the fast-track of The Rotterdam Eye Hospital.

Fast-track, The Rotterdam Eye Hospital

Visit ***one***: patient undergoes the out-patient consultation and all necessary pre-operative assessments. Visit ***two***: patient undergoes surgery. The first review after surgery is done by telephone. Two visits to the hospital in total.

Patients that undergo the ophthalmic screening and/or undergo a consultation with the internist, are normally excluded from the fast-track as both sub-process take place during an additional visit to the hospital. Therefore, The Rotterdam Eye Hospital should focus on the necessity of both sub-process for cataract patients.

The internist

Based on interviews with members of staff and our experiences gained during the case studies, we believe that the consultation with the internist is redundant for cataract patients. In the current situation, the anesthesiologist and the internist are both responsible for the patient's general health. However, the anesthesiologist fulfills the supervision during surgery. Therefore, we recommend to make the anesthesiologist responsible for the patient's general health before and during surgery. The current paper screening by the anesthesiologist should be maintained. However, it is recommended that the screening takes place whilst the patient is still in the hospital. When the anesthesiologist decides that additional assessments are necessary, the patients ***should*** have the opportunity to undergo these during the same visit. Patients that are normally referred to the internist, should be able to visit the anesthesiologist directly in order to be declared fit for surgery.

The ophthalmic screening

The ophthalmic screening is based on the principle that the ophthalmologist that diagnoses the patient isn't always the one that will carry out the surgery. In The Rotterdam Eye Hospital, there are three scenarios by which the ophthalmic screening is planned:

1. The ophthalmologist makes the decision for the ophthalmic screening during the out-patient consultation.
2. The patient requires to undergo the ophthalmic screening.
3. The surgeon decides after the paper screening to plan the ophthalmic screening.

We recommend using the process design of Moorfields Eye Hospital as a model for The Rotterdam Eye Hospital. In Moorfields Eye Hospital, the ophthalmic screening never takes place. Surgeons rely on the information obtained during the out-patient consultation. Appropriate adjustment of knowledge between the diagnostic and the surgical phase may avoid the ophthalmic screening for at least the straightforward cataract patients. Therefore, we recommend a process design that labels straightforward cataract patients during the out-patient consultations. These patients don't need to undergo an ophthalmic screening. Furthermore, we recommend that patients should not have the opportunity to require the ophthalmic screening when that isn't necessary for medical reasons.

Recommendations for The Rotterdam Eye Hospital

- Make the anesthesiologist responsible for the patient's general health before and during surgery.
- Patients should not have the opportunity to require an ophthalmic screening by their selves.
- Straightforward cataract patients don't need an ophthalmic screening during the pre-operative phase.

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **4**	**14**%	36%	0%

In the current situation, patients preferably are diagnosed during the cataract consulting hours. However, the capacity of the cataract-only consulting hours is insufficient. We recommend to increase the capacity of the cataract consulting hours in order to increase the ***efficiency***.

Recommendation for The Rotterdam Eye Hospital

- Increase the capacity of the cataract consulting hours.

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **14**	**68**%	100%	0%

We believe that the review by telephone, or the self-review to execute the first review after surgery are good methods to avoid a visit to the hospital. Although, we assume that the current process design in which 32% of the patients come to the hospital don't leave much room for further improvements as the number of patients that don't need an ophthalmic first review is restricted. Therefore, we recommend using the process design of Moorfields Eye Hospital as a model by executing the first review on the day of surgery.

Recommendation for The Rotterdam Eye Hospital

- Execute the first review after surgery on the day of surgery.

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

Positively associated with operational effectiveness	Rotterdam	London	New York
Hypothesis **9**	**64**%	69%	84%

We don't know why The New York Eye and Ear Infirmary scores better on this indicator in comparison to the other hospitals. For that reason, we are unable to propose recommendations in order to improve the ***operational effectiveness***.

Figure 10 displays the proposed recommendations for The Rotterdam Eye Hospital in a flowchart. The green boxes are new sub-processes, the red boxes are omitted sub-processes, and the grey boxes are unchanged sub-processes.

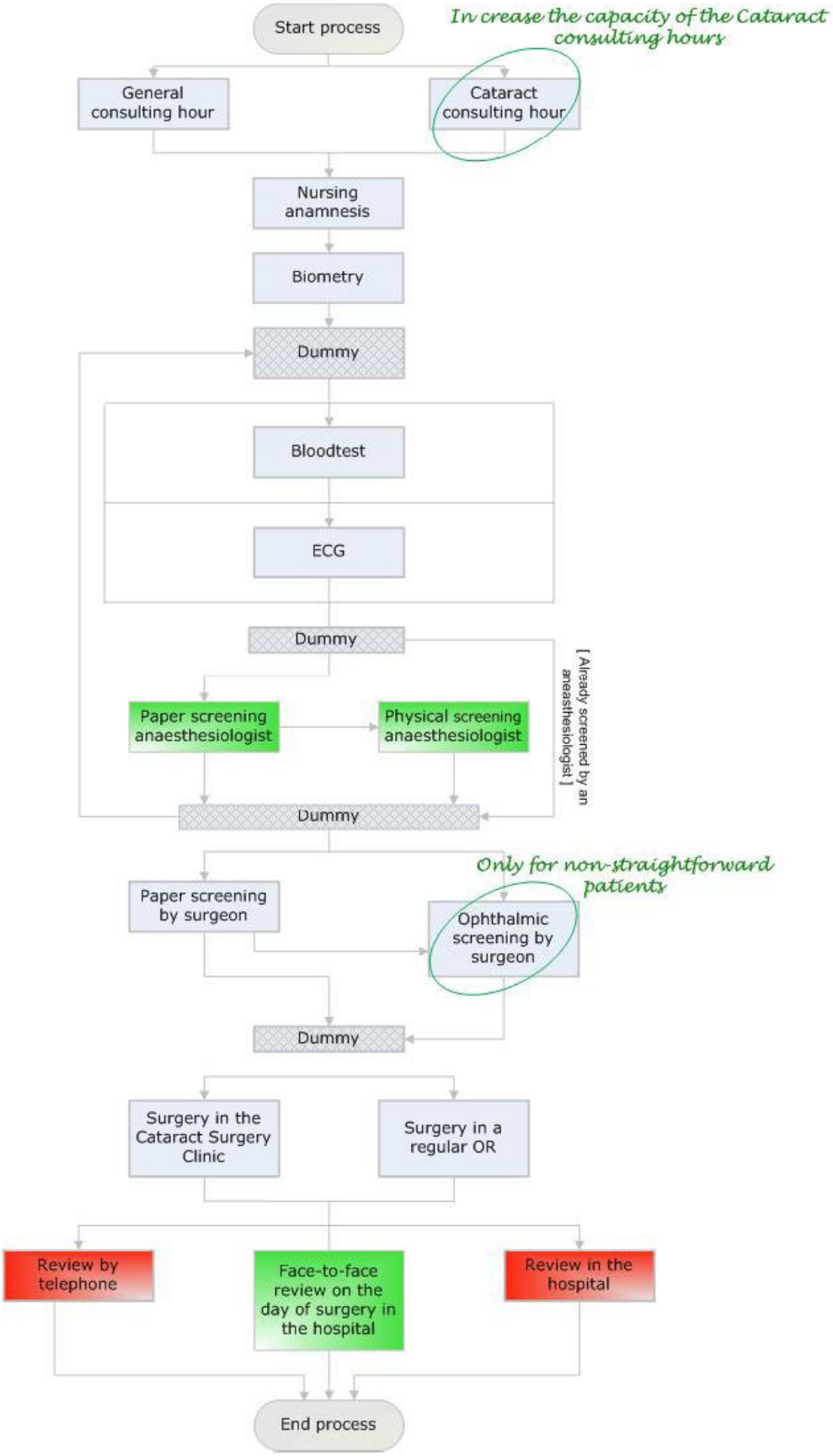


Figure 10; Recommended flowchart, The Rotterdam Eye Hospital

10.2 Recommendations for Moorfields Eye Hospital

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **3**	31%	**38**%	29%

The output of this indicator is affected by the organizational design of all phases of the cataract process. We recall our definition of the fast-track of Moorfields Eye Hospital.

Fast-track, Moorfields Eye Hospital

Visit ***one***: a patient undergoes the out-patient consultation at the Cataract Clinic and undergoes all necessary pre-operative assessments on the same day. Visit ***two***: a patient undergoes surgery and the first review after surgery. Two visits to the hospital in total.

Patients that are referred for the first out-patient consultation to the Primary Care Clinic are excluded from the fast-track, as:

- They don't have the opportunity to undergo the pre-operative assessments on the same day.
- They are referred to the Cataract Clinic for another out-patient consultation that doesn't take place on the same day.

Therefore, Moorfields Eye Hospital ***should*** focus on the referrals from the Primary Care Clinic to Cataract Clinic and the alignment between the Primary Care Clinic and the Pre-operative assessment Clinic.

Referral from the Primary Care Clinic to the Cataract Clinic

Within the framework of this research, we are unable to propose recommendations concerning the screening of the referral letters at the booking center. Therefore, we focus on the referrals from the Primary Care Clinic to the Cataract Clinic. We know that the non-medical members of staff in the Primary Care Clinic are unaware of the size of the patient flow between the Primary Care Clinic and the Cataract Clinic. The indicator, which is reliable, shows that more than 50% of all patients are referred from the Primary Care Clinic to the Cataract Clinic. An important reason for this referral is the need to verify the diagnosis cataract. We recommend to examine the underlying reasons for these internal referrals. We believe that the straightforward cataract patients that account for at least 50% of all patients, don't need to undergo the second out-patient consultation at the Cataract Clinic.

Alignment between the Primary Care Clinic and the Pre-operative assessment Clinic

The Cataract Clinic claims schedule time in advance at the Pre-operative assessment Clinic such that cataract patients have direct accessibility. We recommend the Primary Care Clinic to do the same. In the recommended situation, cataract patients that undergo their out-patient consultation at the Primary Care have the opportunity to undergo the pre-operative assessments on the same day.

Recommendations for Moorfields Eye Hospital

- Examine the underlying reasons for internal referrals from the Primary Care Clinic to the Cataract Clinic in order to decrease this patient flow.
- Make the Pre-operative assessment Clinic accessible on the same day for cataract patients that are diagnosed at the Primary Care Clinic.

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **4**	14%	**36**%	0%

As already mentioned before, we are unable to propose recommendations concerning the screening of the referral letters at the booking center. Therefore, we are unable to assess the possibility to increase the number of patients that are directly referred to the Cataract Clinics. The limited capacities at the Cataract Clinics force some patients to be diagnosed at the Primary Care Clinic. Therefore, we recommend to increase the capacity of the Cataract Clinics in order to increase the ***efficiency***.

Recommendation for Moorfields Eye Hospital

- Increase the capacity of the Cataract Clinics.

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **14**	68%	**100**%	0%

Since we consider Moorfields Eye Hospital to be best practice in this respect, we don't suggest recommendations regarding this hypothesis.

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

Positively associated with operational effectiveness	Rotterdam	London	New York
Hypothesis **9**	64%	**69**%	84%

We don't know why The New York Eye and Ear Infirmary scores better on this indicator in comparison to the other hospitals. For that reason, we are unable to propose recommendations in order to improve the ***operational effectiveness***.

Figure 11 displays the proposed recommendations for Moorfields Eye Hospital in a flowchart. The green arrow should be available on the same day as the consultation in the Primary Care Clinic, the patient flow through the red arrow should be avoided, and the grey boxes are unchanged sub-processes.

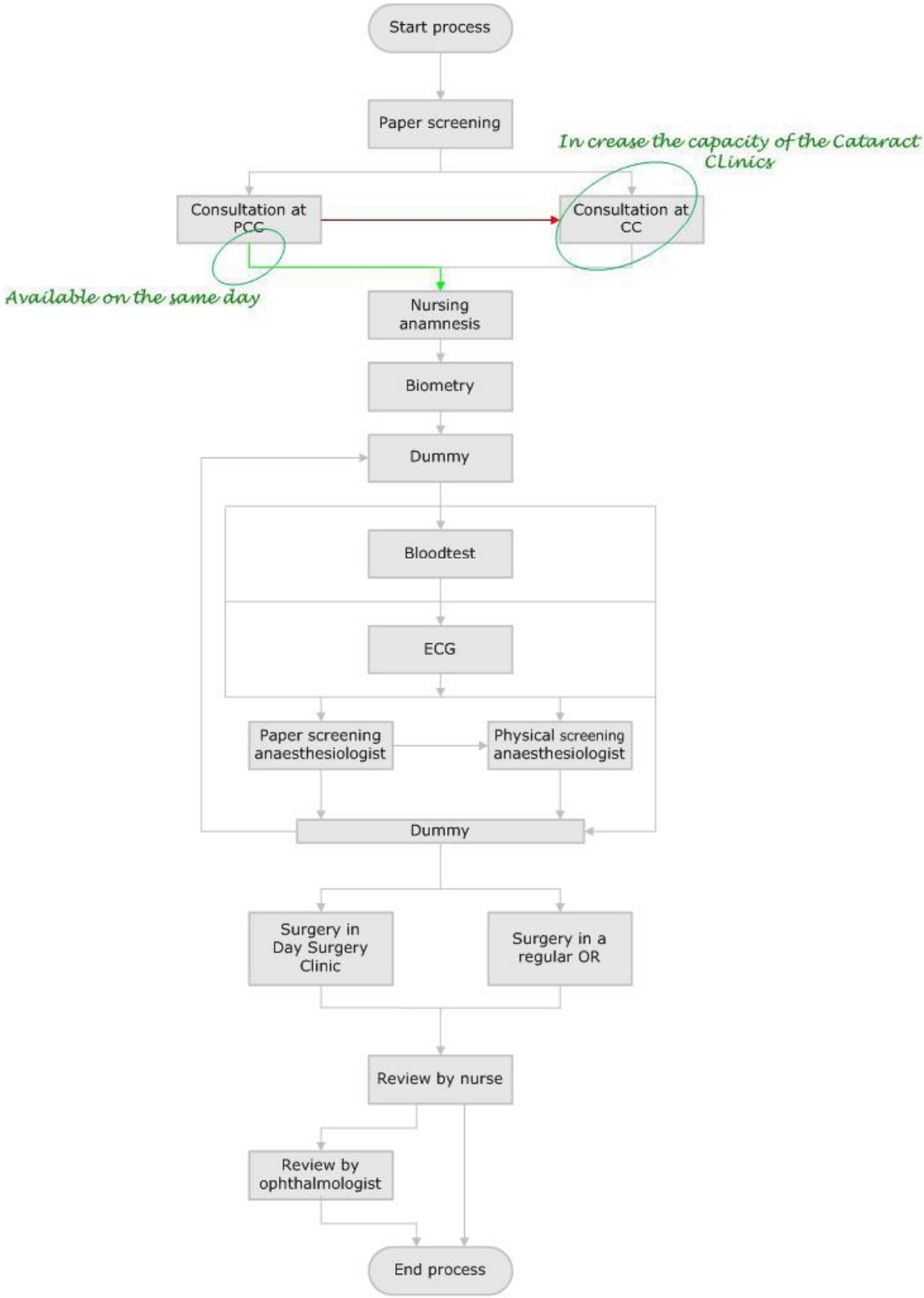


Figure 11; Recommended flowchart, Moorfields Eye Hospital

10.3 Recommendations for The New York Eye and Ear Infirmary

Hypothesis 3

Using a separated pathway for (1) straightforward cataract patients and for (2) non-straightforward cataract patients with ocular comorbidity, medical and/or social conditions, has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **3**	31%	38%	**29**%

The output of this indicator is affected by the organizational design of all phases of the cataract process. We recall our definition of the fast-track of The New York Eye and Ear Infirmary.

Fast-track, The New York Eye and Ear Infirmary

Patients that undergo same day testing during the pre-operative phase.

Clinic patients are excluded to undergo same day testing without any reason. Same day testing is for The New York Eye and Ear Infirmary a good opportunity to compensate the extra visits to the hospital during the diagnostic and the post-operative phase. In the current situation, 28.8% of all patients undergo same day testing. We recommend to focus on increasing this number and to start offering this opportunity to clinic patients as well.

Recommendation for The New York Eye and Ear Infirmary

- The New York Eye and Ear Infirmary should focus on increasing the number of patients that undergo same day testing.
- Clinic patients should have the opportunity to undergo same day testing.

Hypothesis 4

Using dedicated resources (e.g. cataract-only consulting hours) during the diagnostic phase to execute the first out-patient consultation has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **4**	14%	36%	**0**%

Since only clinic patients are diagnosed ***inside*** the hospital, and clinic patients make up 8,1% of all cataract patients, we don't recommend to implement dedicated resources in the diagnostic phase. Therefore, we don't propose recommendations.

Hypothesis 14

Avoiding an extra visit to the hospital to execute the first review after surgery, has a positive effect upon the process-alignment.

Positively associated with efficiency	Rotterdam	London	New York
Hypothesis **14**	68%	100%	**0**%

We believe that the process design of The New York Eye and Ear Infirmary doesn't leave much room for improvements with regard to this hypothesis. During the entire process, the ophthalmologists are responsible for their own patients' ophthalmic conditions. We assume that the health system doesn't leave room for ophthalmologists to execute the first review in another way than during a face-to-face consultation, or that someone else executes the review. To execute the review directly after surgery is hampered since the surgeons are restricted by the limited assigned block time. For those reasons, we are unable to propose feasible recommendations.

Hypothesis 9

The process is better aligned when cataract patients undergo surgery in a Day Surgery Clinic, instead of in a regular operating room.

Positively associated with operational effectiveness	Rotterdam	London	New York
Hypothesis **9**	64%	69%	**84**%

The New York Eye and Ear Infirmary is the best aligned in comparison to the other hospitals. However, we didn't use the process design of The New York Eye and Ear Infirmary as a model for the other hospitals as we can't explain ***why*** the hospital scores better. There is no hospital policy that describes which patients are qualified to undergo surgery at the Day Surgery Clinic, that decision is upto the surgeon. For that reason, we don't propose recommendations based on this process design and we don't propose recommendations to The New York Eye and Ear Infirmary.

Figure 12 displays the proposed recommendations for The New York Eye and Ear Infirmary in a flowchart. The green boxes are new sub-processes, the red boxes are omitted sub-processes, and the grey boxes are unchanged sub-processes.

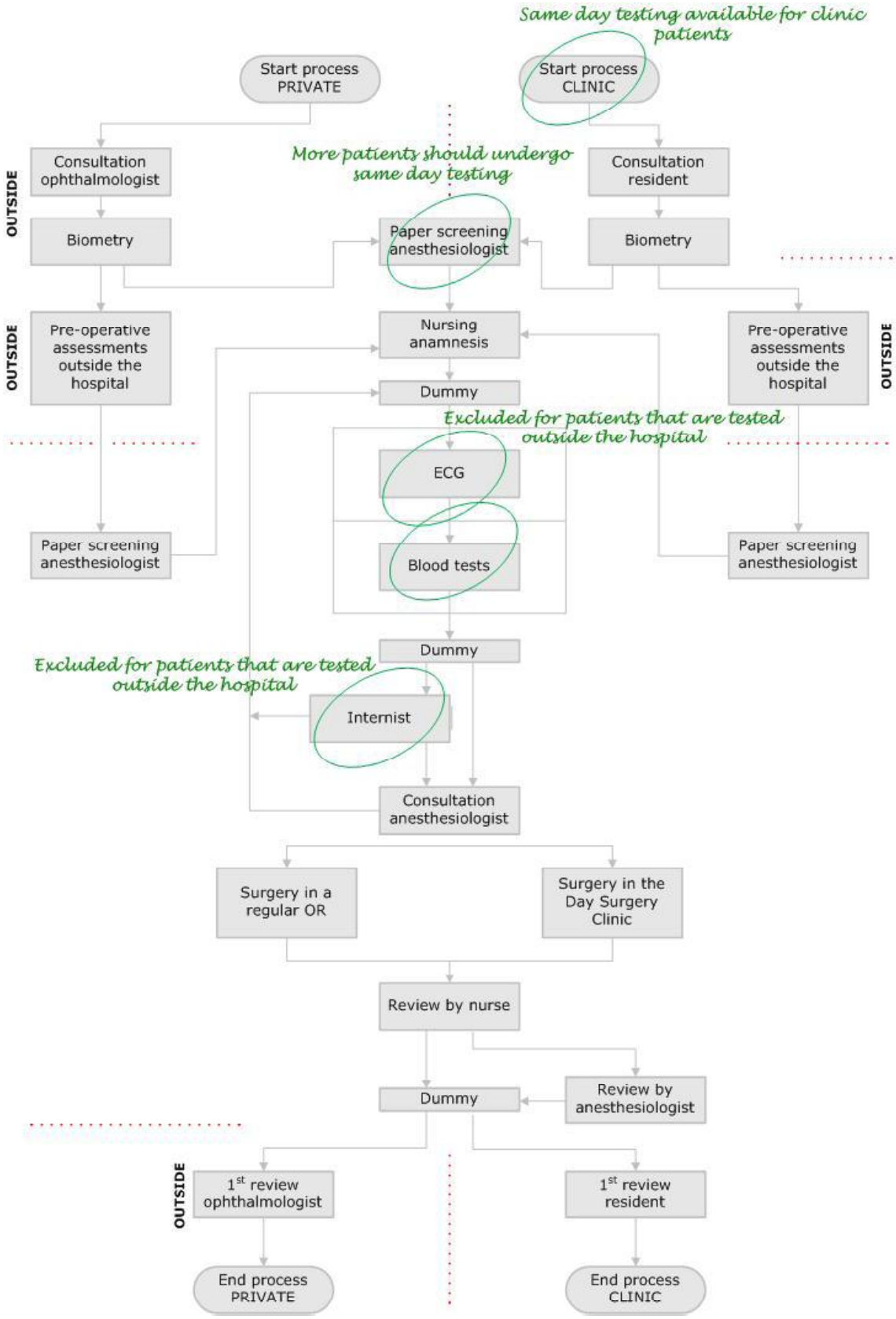


Figure 12; Recommended flowchart, The New York Eye and Ear Infirmary

11. Conclusion

In this chapter we come to the conclusions of our research. We started this research with the formulation of the objective:

'To study the ***association*** between process-alignment, efficiency and operational effectiveness of care delivery systems in focused factories by analyzing and comparing the cataract processes of three international good practice hospitals'

We examined the ***relation*** as the ***association*** between variables, defined as:

'Two variables measured on the same process are associated when some values of one variable tend to occur more often with some values of the second variable than with other values of that variable.'

The main hypothesis we accept or reject is:

'A higher extent of process-alignment is ***positively associated*** with increased efficiency and operational effectiveness of the cataract process'

We formulated two main research questions:

I.	What is the relation between process-alignment, efficiency and operational effectiveness of care delivery systems in Focused Factories?
II.	What recommendations can be made concerning the process-alignment of the cataract process of The Rotterdam Eye Hospital, Moorfields Eye Hospital and The New York Eye and Ear Infirmary?

We looked at the cataract process in three international eye hospitals. The cataract process was defined as:

'The successive sub-processes a cataract patient go through in order to cure the cataract, starting with the first out-patient consultation in the eye hospital and ending after the first review after surgery'

Research question II was answered in chapter 10. Research question I is discussed in this chapter.

In section 11.1, we elaborate on the relation between process-alignment, efficiency and operational effectiveness based on the case studies, the hypotheses and our observations. In section 11.2, we discuss what we consider to be the essential elements of process-alignment. In section 11.3, we propose recommendations for further research.

11.1 The relation between process-alignment, efficiency and operational effectiveness

The framework includes 15 hypotheses and corresponding indicators that all propose a possible relation between process design and process-alignment. The hypotheses together cover all phases of the cataract process. We formulated 4 indicators to measure the efficiency and four indicators to measure the operational effectiveness of the process. 2 indicators for efficiency, and 2 for operational effectiveness were excluded from the comparison as these were impossible to be provided by the hospitals.

We assessed the hypotheses on their relevance within the research, based on the gained experiences and the scores on the indicators. We considered 10 hypotheses relevant. We examined for 8 ***relevant*** hypotheses if the extent of process-alignment is associated with the efficiency and/or the operational effectiveness of the process. 2 relevant hypotheses and 1 indicator to measure the efficiency were excluded as the score of at least one hospital was unreliable.

We suspect ***positive association*** with ***efficiency*** for 3 hypotheses and we suspect ***positive association*** with ***operational effectiveness*** for 1 hypothesis. This implies that we demonstrated for 4 out of 8 relevant hypotheses an association with either efficiency or operational effectiveness.

We ***conclude*** that this research demonstrates positive association between the extent of process-alignment and the efficiency of the cataract process. Furthermore, based on the gained experiences from the case study, we ***suspect*** positive association between the extent of process-alignment and the operational effectiveness of the cataract process.

Therefore, we accept the main hypothesis:

'A higher extent of process-alignment is ***positively associated*** with increased efficiency and operational effectiveness of the cataract process'

ACCEPTED

To measure the process-alignment

The scores on the indicators of 10 hypotheses corresponded with our observations during the cases studies. These hypotheses are considered as relevant tools to measure the extent of process-alignment. We believe that the formulation of a framework including 15 hypotheses of which 10 hypotheses are considered relevant in an international context was a good approach within the framework of this research.

To measure the efficiency and operational effectiveness

4 indicators were formulated to measure the efficiency and 4 indicators were formulated to measure the operational effectiveness. Prior to the comparison, we left 4 indicators out of consideration. 2 indicators for both variables left over for the comparison. One score on the indicator for efficiency was considered unreliable such that this indicator was not appropriate to demonstrate an association. We believe that it would have improved the reliability of the research when there were more indicators available to reflect the efficiency and operational effectiveness of the process. However, a risk of the current research design in which we didn't aim to measure the indicators by ourselves, was that some indicators should became unavailable and that we were unable to change that situation.

The international case studies

We visited two eye hospitals abroad. ***Was the international context of the research appropriate to study the relation between process-alignment and process design?*** We believe the answer is yes. The international context has a positive effect upon the diversity of the cases and therefore upon the contribution to knowledge of focused factories in hospital care. We assume that is was impossible to select three comparable ophthalmic focused factories in the Netherlands to participate within the framework of this research. On the other hand, the international context bring some complexities as well. It was impossible to visit the foreign hospitals several times and sometimes the communication hampered the research. However, we didn't face insurmountable problems and we accomplished all goals we formulated for the case studies abroad.

11.2 The essential elements of process-alignment

In section 11.1, we discussed the relation between process-alignment, efficiency and operational effectiveness based on the cases studies. In this section we discuss what we consider to be the most essential elements of process-alignment in focused factories. We recall the definition of process-alignment:

Process-alignment
The extent to which the sub-processes of a care delivery system fit to each other, and fit to the chosen type of focus, regarding the served patients and offered services.

In order to:

- Smoothen the patient's flow through the process
- Reduce waste
- Reduce waiting times for as well patients as professionals

By:

- Preventing interruptions from other processes
- And synchronizing:
    - All executed primary and supporting procedures
    - Operational planning systems
    - Capacities
    - Resources in the field of:
        - Personnel
        - Medical Technology
        - Knowledge

We believe that the most important aspect of process-alignment is the extent to which the sub-processes of a care delivery system fit to each other. The performance of the entire process is affected by the performance of each sub-process and by the fit between the sub-processes. Dedicated resources to execute the sub-processes has a positive effect upon the ***performance*** of the sub-process. However, the synchronization of capacities, operational planning systems and resources in the field of personnel, medical technology and knowledge have a positive effect upon the ***process-alignment***. We believe that ***synchronization*** is the key-element of process-alignment. Process-alignment is positively associated with efficiency and operational effectiveness. Therefore, the recommendations for focused factories in hospital care is to focus on the synchronization between the sub-process in order to increase the process-alignment, efficiency and operational effectiveness.

11.3 Recommendations for further research

Moorfields Eye Hospital opened in 2007 an outreach location that is fully dedicated to the cataract process, called Moorfields Cataract Clinic. We were in confusion about to what extent we should included Moorfields Cataract Clinic in the comparison as the process design was significantly different to the design of the other locations. We assume that separating the cataract process, like establishing a cataract-only clinic, has a positive effect upon the efficiency and operational effectiveness of the process. To accept or reject this assumption, we recommend further research to examine the process performance of Cataract Clinics like Moorfields Cataract Clinic in comparison with other focused factories. One should focus on the advantages and disadvantages of the usage of dedicated resources and if this dedication has a positive effect upon the efficiency and/or operational effectiveness. If the answer is positive, it could be interesting to find out for how many treatments per year the establishment of a fully dedicated clinic generates the intended positive effects.

12. Personal reflection

In this chapter we look back on the course of the research. We reflect on the research approach and discuss what we could have done better.

12.1 The course of the research

This project was the first cooperation between the University of Twente and The Rotterdam Eye Hospital. We used the first meetings to introduce both parties, to synchronize the wants and expectations and to select the topic for the research.

In the first two months, we formulated the research approach and a rough research planning. The initial schedule proposed to finish the research before Christmas 2007. Due to the summer break and the preparation of the case studies abroad that took more time than we expected, the planning was rescheduled. Eventually, we carried out all case studies in 2007 and finished the entire project in March 2008.

We were honored to have the opportunity to visit two foreign eye hospitals located in two famous metropolitans in the world. However, staying for about two weeks in both cities was too expensive within the available budget for the project. Due to a lot of exploration and flexibility, it was possible to stay for two weeks in London and for one week and a half in New York. The case study in The Rotterdam Eye Hospital didn't need overnights in Rotterdam as it was possible to travel each day from The Hague.

The case studies were very interesting and informative. Although it wasn't that easy to start up, work out and finish a case study in a new environment, dealing with people that are not familiar with the topic, in a short period of time, we accomplished all goals we set prior to the visits (see section 5.2).

12.2 What could we have done better?

- The visits abroad needed a decent preparation within the framework of the research. However, these visits needed a decent preparation concerning the organizational side of the trips as well. We should have planned off one week before and a half week after both trips to approach the realistic time we spent on it. We only took the research related time into account, which caused unexpected delay.
- We sent the intentions of the research, the hypotheses and the indicators to the hospitals prior to our visits. We did realize that we had to modify the indicators to the specific cases abroad and that it would take time to inform the hospitals about the objective of the research. However, we didn't realize (enough) that it would take a significant amount of time for the hospitals to provide the required data. The latter is underestimated. We recommend three scenarios to avoid problems concerning these misunderstandings in the further:
  - Make sure the participated hospitals know that it would take time to provide the required data.
  - Measure the indicators instead of asking for cut and dried data.
  - Require raw data.
- We left the hospitals abroad without all the required information. We agreed on appointments to forward the information afterwards. Although we made clear appointments that were confirmed by e-mail, it wasn't easy to keep in control of the project from another location. The next time we should formulate a research approach that takes this difficulty into account.

- We aimed to select three similar hospitals regarding the size, the expertise and the type of delivered care to improve the comparability. However, we should have focused on the adjustment of the cataract processes instead of the preconditions. The New York Eye and Ear Infirmary dealt with patients that undergo parts of the process outside the hospital. This has affected the comparability of the cases. The same applies to the outreach locations of Moorfields Eye Hospital. Both characteristics have significantly reduced the comparability and may therefore affected the results of the research.

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