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Enschede - The Netherlands

Focused Factories and Efficiency

A Comparison of Orthopaedic Departments

L.J. Admiraal

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Student number: 0005746

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Graduation committee:
Prof. W.H. van Harten MD PhD (University of Twente, faculty Management & Governance)
E. Bredenhoff MSc (University of Twente, faculty Management & Governance)

Management Summary

In a four year project of the University of Twente and the Maastricht University the applicability of focused factories on Dutch hospital care is subject of research. This is the second year of this project. This year the emphasis of the research is placed on the relationship between focused factories and efficiency of healthcare processes. The research aim is to find out what the effects on efficiency are of focusing on one patient category.

Focused factories

In previous research by Van Lent (2005), the following definition of focused factories was formulated:

> *A focused factory is (an autonomous part of) an organization that is characterized by a focus upon a limited range of activities and/ or a focus on a well-defined, limited group of patients and an alignment of all the involved processes to these focus areas. This process alignment implicates that continuous improvements are an aim of the organization.*

Based on this definition a categorization instrument was developed (Van Lent, 2005), that allows us to assess if (a part of) an organization is a focused factory. The two dimensions that determine this are the degree of focus on a limited range of activities and/ or the focus on a well-defined category of patients. This leads to four categories of focused factories (labelled type I-IV). The categories II, III and IV are perceived as focused factories, for these have a focus on either patients, services, or both.

Efficiency

In literature, efficiency is defined in many ways. A general definition of efficiency is the ratio of inputs and outputs. It can be defined in either money, or through indices. For this research a new set of efficiency measures is developed, based on (parts of) the model of Waring (2000) and a general description of the orthopaedic patient processes. Most important inputs are 'workforce' and 'equipment'. The most important output is the number of treated patients.

Hypotheses

Four hypotheses on the relation between focus and efficiency, were formulated:

Hypothesis 1: focussing on a limited number of patient categories leads to a higher efficiency.

Hypothesis 2: focussing on a limited number of services leads to a higher efficiency.

Hypothesis 3: if all else stays stable, there is a maximum on the efficiency increase that a hospital can achieve through focus.

Hypothesis 4: orthopaedic departments that separate their inpatient and outpatient activities will be more efficient.

Case studies

Research is done in two hospitals (labeled 1 and 2), to check if these hypotheses are correct. Hospital 1 is a Dutch general hospital with a joint care unit for knee and hip patients. Hospital 2 is a Dutch orthopaedic specialty hospital, that has not got a joint care unit, but could develop such a unit. For both hospitals the orthopaedic departments were subject of research. Also the results of their knee patients were compared.

The orthopaedic departments of hospital 1 and 2 are focused on a patient category and are not focused on offered services. Therefore, the departments are categorized as type II focused factories. Since, the joint care unit of hospital 1 is focused on patients as well as on

services, it is categorized as a type IV focused factory. The knee group of hospital 2 could also be focused on patients and services and, therefore, is categorized as a potential type IV focused factory.

Conclusions

However, the categorization of the orthopaedic departments of both hospitals and the potential knee group of hospital 2 are disputable. The focus scores of these departments and unit are close to each other and the borders of their type. A small misinterpretation during the case studies could have resulted in an other type of focus.

Comparison of the efficiency results of the orthopaedic departments displayed differing results regarding the relation between focus and efficiency. Focus on patients seems to be more efficient for inpatient care, the diagnosing process and the number of outpatient clinic return visits. However, focus on patients seems to be less efficient in day-care and in overhead and support. Because of a lack of comparable data, we could not draw conclusions on the relation between focussing on services and efficiency.

Focussing makes services more specific and, therefore suitable for a smaller group of patients. Since, this makes the target group smaller, we assume, that in stable situations, there is a maximum on the efficiency increase that can be achieved through focus. Based on the efficiency results for inpatient and day care, separating inpatient and outpatient activities seems to be more efficient.

Therefore, we assume that in certain situations focus leads to more efficiency. In other situations the opposite is true, or the effect is not clear. The effect focus has on efficiency is also influenced by the process alignment of the focused factory.

Recommendations

Based on these conclusions, some recommendations are made to the hospitals.

The most important recommendation for hospital 1 is to make changes in the organization of its joint care unit. Knee and hip patients should no longer be treated at the same time in the same joint care unit. Moreover, hospital 1 is recommended to do research in performing similar operations sequentially and should consider to stop using mixed inpatient and day care departments.

Based on the conclusion that focus on patients leads to more efficiency, hospital 2 is recommended to start a joint care unit for its knee patients. Hospital 2 should also consider dividing its patients more strictly over its inpatient departments, based on the injured part of the body.

Further research in hospitals with a comparable case-mix should point out, what effect focussing on services has on efficiency.

Management samenvatting

In een vier jaar durend project van de Universiteit Twente en de Universiteit Maastricht wordt de toepasbaarheid van focused factories op de Nederlandse ziekenhuiszorg onderzocht. Dit is het tweede jaar van dit project. Dit jaar ligt de nadruk op de relatie tussen focused factories en de efficiëntie van zorgprocessen. Het doel van dit onderzoek is te achterhalen wat de effecten van focussen op één patiëntengroep zijn op efficiëntie.

Focused factories

In eerder onderzoek door Van Lent (2005) is de volgende definitie van focused factories opgesteld:

> *Een focused factory is (een autonoom onderdeel van) een organisatie, dat wordt gekenmerkt door een focus op een beperkt scala van activiteiten en/ of een focus op een goed afgebakende, beperkte patiëntengroep en een organisatie van al de processen die betrekking hebben op de focusgebieden. Deze procesorganisatie impliceert dat continue verbetering een doel is van de organisatie.*

Op basis van deze definitie is een categorisatie instrument ontwikkeld (Van Lent, 2005), dat ons in staat stelt om te beoordelen of (een onderdeel van) een organisatie een focused factory is. De twee dimensies die dat bepalen zijn de mate van focus op een beperkt scala van activiteiten en/ of de focus op een goed afgebakende patiëntengroep. Dit leidt tot vier categorieën van focused factories (type I-IV genoemd). De categorieën II, III en IV worden opgevat als focused factories, want die hebben een focus op patiënten, of diensten, of beide.

Efficiëntie

In literatuur wordt efficiëntie op vele manieren gedefinieerd. Een algemene definitie is de hoeveelheid input per output. Dit kan worden gedefinieerd in geld, of door middel van indicatoren. Voor dit onderzoek is een nieuwe set efficiëntiematen opgesteld, gebaseerd op (delen van) het model van Waring (2000) en een algemene omschrijving van het orthopedisch patiëntenproces. De belangrijkste inputs zijn 'werkkrachten' en 'apparatuur'. De belangrijkste output is het aantal behandelde patiënten.

Hypotheses

Vier hypotheses die de relatie tussen focus en efficiëntie beschrijven, zijn opgesteld:

Hypothese 1: focus op een beperkte patiëntengroep leidt tot grotere efficiëntie.

Hypothese 2: focus op een beperkt aantal diensten leidt tot grotere efficiëntie.

Hypothese 3: in een stabiele situatie, is er een maximale efficiëntietoename die bereikt kan worden door middel van focus.

Hypothese 4: orthopedieafdelingen die hun klinische en poliklinische activiteiten splitsen zullen efficiënter zijn.

Case studies

Onderzoek is gedaan in twee ziekenhuizen (ziekenhuis 1 en 2 genoemd), om te controlleren of deze hypotheses correct zijn. Ziekenhuis 1 is een Nederlands, algemeen ziekenhuis met een joint care afdeling voor knie- en heuppatiënten. Ziekenhuis 2 is een Nederlands, orthopedisch ziekenhuis, dat geen joint care afdeling heeft, maar wel een dergelijke afdeling zou kunnen opzetten. Van beide ziekenhuizen is de orthopedieafdeling onderzocht. Ook zijn de resultaten van hun kniepatiënten onderzocht.

De orthopedieafdelingen van ziekenhuis 1 en 2 hebben een focus op een patiëntengroep en geen focus op aangeboden diensten. Daarom zijn die afdelingen gecategoriseerd als type II focused factories. Aangezien de joint care unit van ziekenhuis 1 is gefocused op patiënten en diensten, is het gecategoriseerd als een type IV focused factory. De kniegroep van ziekenhuis 2 kan ook gefocused zijn op patiënten en diensten en is daarom gecategoriseerd als een potentiële type IV focused factory.

Conclusies
Desondanks is de categorisering van de orthopedieafdelingen van beide ziekenhuizen en de potentiële kniegroep discutabel. De focus scores van die afdelingen liggen dicht bij elkaar en dicht bij de grenzen van de types. Een kleine misinterpretatie tijdens de case studies zou geresulteerd kunnen hebben in een ander focustype.

De vergelijking van de efficientieresultaten van de orthopedieafdelingen liet verschillende uitkomsten zien voor de relatie tussen focus en efficiëntie. Focus op patiënten lijkt te leiden tot meer efficiëntie voor klinische zorg, het diagnoseproces en het aantal poliklinische herhaalbezoeken. Terwijl focus op patienten minder efficiënt lijkt te zijn in dagbehandeling en in overkoepelende en ondersteunende diensten. Bij gebrek aan vergelijkbare gegevens, kunnen we geen uitspraak doen over de relatie tussen focus op diensten en efficiëntie.
Focus maakt diensten specifieker en, daardoor, geschikt voor een kleinere groep patiënten. Aangezien, als gevolg daarvan de doelgroep kleiner wordt, nemen we aan, dat in een stabiele situatie er een maximale efficiëntietoename is, die bereikt kan worden door middel van focus. Op basis van de efficiëntieresultaten voor klinische zorg en dagbehandeling, lijkt het splitsen van klinische en poliklinische zorg te leiden tot meer efficiëntie.

Daarom nemen we aan dat in bepaalde situaties focus leidt tot meer efficiëntie. In andere situaties is dit niet het geval, of is het effect onduidelijk. Daarnaast, wordt het effect dat focus heeft op efficiëntie mede beïnvloed door de procesorganisatie in en rondom de focused factory.

Aanbevelingen
Op basis van deze conclusies is een aantal aanbevelingen gedaan aan de ziekenhuizen.
De belangrijkste aanbeveling voor ziekenhuis 1 is om een paar veranderingen door te voeren in de organisatie van de joint care unit. Knie- en heuppatiënten zouden niet langer op hetzelfde moment in dezelfde joint care unit behandeld moeten worden. Bovendien wordt ziekenhuis 1 aangeraden om onderzoek te doen naar het achter elkaar plannen van gelijke operaties en zou het moeten overwegen om te stoppen met de gemengde klinische en dagbehandelingsafdelingen.

Op basis van de conclusie dat focus op patiënten leidt tot meer efficientie, wordt ziekenhuis 2 geadviseerd, om te starten met een joint care afdeling voor haar kniepatiënten. Ziekenhuis 2 moet ook overwegen om haar patiënten strikter, op basis van hun aandoening, te verdelen over de verpleegafdelingen.

Vervolgonderzoek in ziekenhuizen met vergelijkbare patiëntengroepen dient uit te wijzen welk effect focus op diensten heeft op efficiëntie.

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Preface

In 2005 the University of Twente and the Maastricht University started a four year research project to find out the applicability of focused factories on Dutch hospital care. In the first year three different types of focused factories in hospitals were described (Van Lent, 2005). Hospitals were categorized based on their degree of focus on patient groups and degree of focus on offered services.

This is the second year of this project. Now the emphasis of the research lies on the relationship between focused factories and efficiency of healthcare processes. The aim is to find out what effects focusing on one patient category has on efficiency. For this research two orthopaedic departments were compared. The first is of a general hospital and also contains a joint care unit. The second is of a orthopaedic specialty hospital.

This report is the result of that research, which also is my graduation assignment for Industrial Engineering & Management. It was impossible to perform this research without the cooperation of, in general, both participating hospitals and, more specific, the interviewed managers, the employees who collected data and the employees I met during the hospital visits. Furthermore, I would like to thank my graduation committee (Prof. W.H. van Harten MD PhD and E. Bredenhoff MSc) for their support, feedback and patience.

Enschede, 15 June 2007
Arjan Admiraal

1 Introduction

In hospitals it is nowadays more important to deliver healthcare in a efficient way due to tight budgets. A way to do this is by implementing focused factories (Herzlinger, 1997).
In a four year project of the University of Twente and the Maastricht University the applicability of focused factories on Dutch hospital care is subject of research. This is the second year of this project. In the first year Van Lent (2005) described three different types of focused factories in hospitals. Hospitals were categorized based on their degree of focus on patient groups and degree of focus on offered services.

This year the emphasis of the research is placed on the relationship between focused factories and efficiency of healthcare processes. The research aim is to find out what the effects on efficiency are of focusing on one patient category. Before being able to do this, it is necessary to find a measure for efficiency in hospitals. This measure will be used to compare an orthopaedic hospital with a joint care unit of a general hospital both in the Netherlands. Comparison will take place at the level of the complete hospital, as well as at the departmental level. Since the orthopaedic hospital is interested in the efficiency of their knee treatment unit the choice is made to examine this patient category.
One should notice, that the comparison of these two categories of hospitals is an unequal comparison. These two categories of hospitals treat patients with very different severity of injuries. Therefore, the hospitals are compared not to see which hospital is the best, but to support the theory on the relation between focus and efficiency presented in this report.

The structure of this report is as follows. Chapter 2 deals with the problem definition and research questions. Chapter 3 is used to describe the recent insights on focused factories. Furthermore, measures for efficiency are discussed and a hypothesis on the relation between focus and efficiency is formulated. Chapter 4 discusses the most important processes in an orthopaedic department and a joint care unit. Furthermore, the case study protocol and the choices regarding the measures for efficiency are discussed in this chapter. Chapter 5 and 6 describe the case study hospitals and the research results. These results are analysed in chapter 7, while in chapter 8 conclusions are drawn. Chapter 9 contains recommendations for both hospitals and for further research. The last chapter is used for reflection on the research.

2 Problem exploration

2.1 Background

In a four year project of the University of Twente and the Maastricht University the applicability of focused factories on Dutch hospital care is studied. Each year a Dutch hospital is compared with one or two (foreign) hospitals based on theories about focused factories.

This is the second year of that project. In the first year three different categories of focused factories in hospitals were described. Hospitals were categorized based on their degree of focus on patient categories and degree of focus on offered services.

This year the emphasis lies on the relation between focused factories and efficiency of healthcare processes. The aim is to find out the relation between focusing on one patient category and efficiency. The research will be performed in an orthopaedic hospital and in a general hospital with a joint care unit.

2.2 Research questions

In this section the research questions will be discussed. First the two main research questions, these are followed by the literature study research questions and the case study research questions.

Main research questions

The first main research question follows from the assignment description, to find out what the relationship is between focused factories and efficiency of healthcare processes:

I. What is the relation between focus and efficiency in general and especially in orthopaedic departments?

Based on the research findings both hospitals cooperating in this research will receive a recommendation on their organization. Therefore, the second main research question is:

II. How can the efficiency of the treatment of knee patients in the cooperating hospitals, using a focus factory framework, be improved?

Literature study research questions

Since this research studies focused factories, the most recent insights regarding this subject will be discussed. This leads to the following research question:

- What are the recent insights on focused factories?

Literature will be examined to find out how the relation is between focus and efficiency. This will lead to a hypothesis that will be studied in the rest of this research.

- How does the relation between focus and efficiency work?
- Does a higher degree of focus lead to more efficiency?

Literature will be examined to find efficiency measures concerning focused processes in hospitals and more specifically in focused factories or -units. A measure seems appropriate if all the variables it measures can also be measured in the focused factories. If such a measure is not available a set of measures will be developed. This set will be based on the measures

used in management literature to measure efficiency in manufacturing and service organizations. This leads to the following research questions:

- How is efficiency measured within (focused) plants and services?
- What is an appropriate efficiency measure on meso level in hospitals?
- What is an appropriate efficiency measure in focused factories?

Case study research questions

The next research questions will be studied to find out what degree of focus the focused factories have. Moreover, the relations of the focused units with other departments in the hospital will be subject of research. These questions are studied, because they might influence the efficiency of the department.

- What is the type of focus of the focused factories?
- How are the focused factory-units embedded in the rest of the organization?
- How does this effect the degree of efficiency?

The relation between efficiency and focus will be studied on different levels in and between the organizations. This leads to three different comparisons, which are illustrated in Figure 1. The numbers in the arrows correspond with the different categories of analysis.

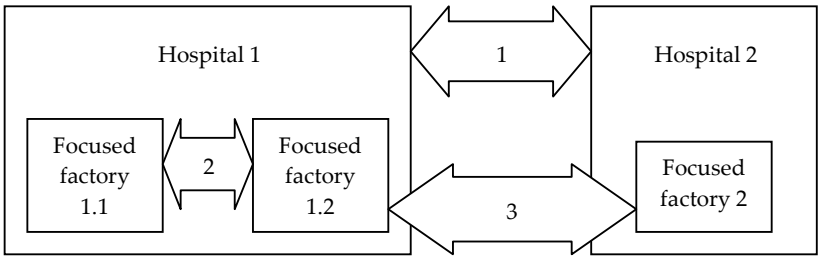

Figure 1: The three categories of analysis

Category 1: Between case study hospitals

The efficiency of the case study hospitals as a whole will be compared. The research questions that will be studied are:

- Do the case study hospitals differ on efficiency?
- Why is one case study hospital more efficient than the other?

Category 2: Between the different focused factories within a case study hospital

If a case study hospital has more than one focused factory for the treatment of the same injury, then the efficiency of the focused factories of that hospital will be compared. The research questions that will be studied are:

- Do the case study hospitals have more than one focused factory for the treatment of the same injury?
- Is there a difference between the efficiency of the different focused factories of one case study hospital?
- What are the main causes for this difference?

Category 3: Between focused factories of different case study hospitals
The focused factories of the different case study hospitals will be compared. The research questions that will be examined are:

- Do the focused factories of the case study hospitals differ in characteristics of its focused organization and on efficiency?
- Why is the focused factory of one case study hospital more efficient than the focused factories of an other case study hospital?

2.3 Research design

The research consists of the following two parts.

1. A literature study that leads to an appropriate measure or framework for efficiency in hospitals and hospital departments.

2. A multiple case study in two hospitals. An orthopaedic department of a general hospital with a joint care unit and an orthopaedic hospital without a joint care unit, both in the Netherlands.

The case studies will take two weeks for each hospital. The first four days of a week will be used to gather data. The fifth day is used for ordering data and transcribing interviews.

2.4 Activities and their relations

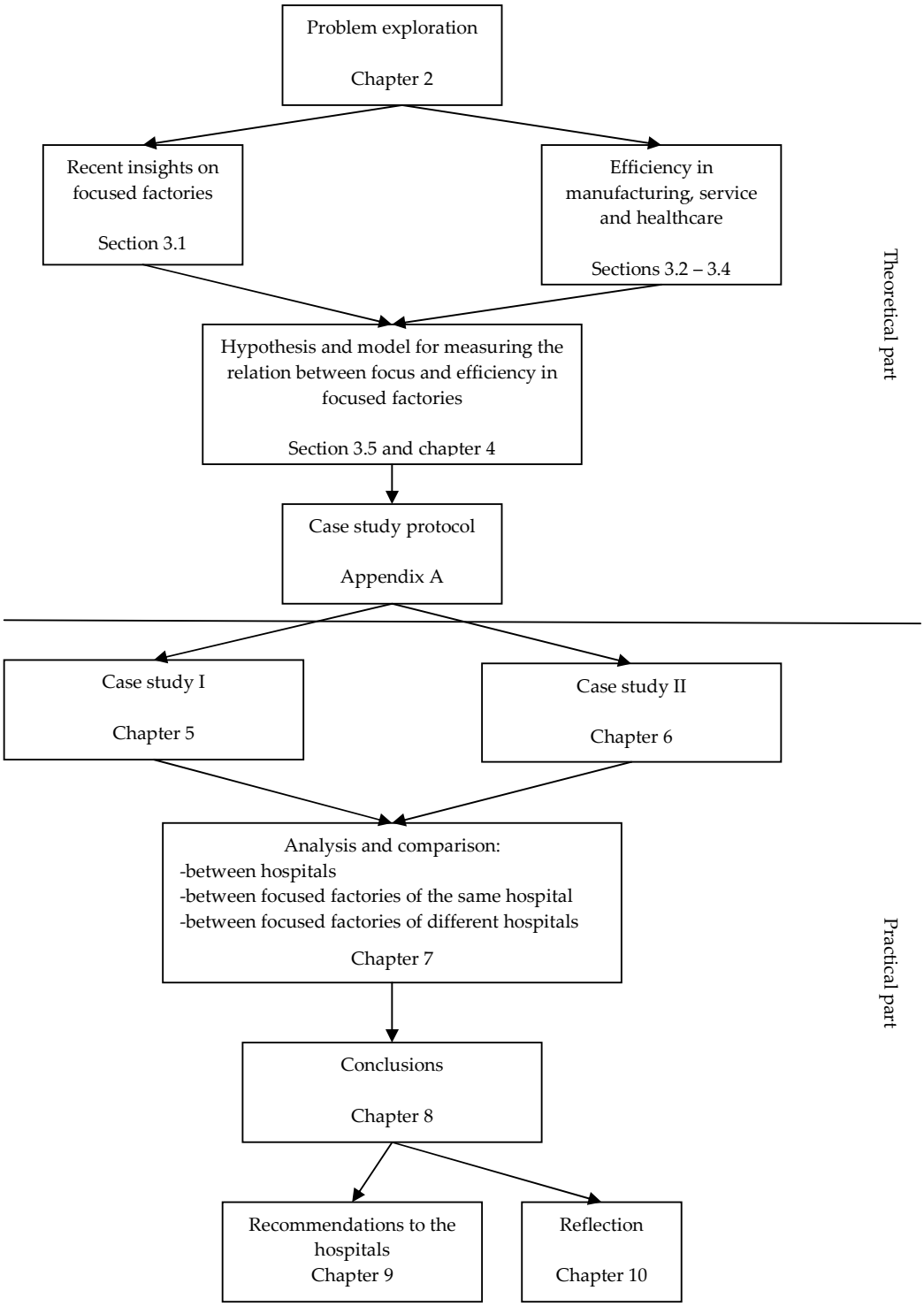

Figure 2: Activities, their relations and chapter number. The horizontal line separates the theory part from the practical part of this research.

3 Focused factories and efficiency

This chapter contains information on focused factories and efficiency. The first section discusses the recent insights on focused factories. In the second, third and fourth section efficiency measures in respectively manufacturing, service organizations and hospitals are presented. Section five handles the relation between focus and efficiency and deals with hypotheses for this research. In the last section the conclusions from this chapter are summarized.

3.1 Recent insights on focused factories

This section deals with the subject of focused factories. The definition used in this research will be given, followed by a classification in four types.

The definition of focused factories in hospitals we use in this research is formulated by Van Lent (2005):

> *A focused factory is (an autonomous part of) an organization that is characterized by a focus upon a limited range of activities and/ or a focus on a well-defined, limited group of patients and an alignment of all the involved processes to these focus areas. This process alignment implicates that continuous improvements are an aim of the organization.*

Based on this definition a categorization instrument was developed (Van Lent, 2005), that makes it possible to assess if (a part of) an organization can become a focused factory. The two dimensions that determine this, are the degree of focus on a limited range of activities and/ or the focus on a well-defined category of patients. An organization is only a focused factory, if its process alignment is high. Hence this factor does not influence the category of focus.

This categorization leads to three possible categories of focused factories. These categories differ from each other based on their degree of focus on offered services and their degree of focus on patient category. This is illustrated in Figure 3. The degree of focus on services is determined by the degree to which (a part of) a hospital performs a limited range of tasks. The degree of focus on patient category is determined by the degree to which (a part of) a hospital serves a limited, selected, well-defined and comparable category of patients, whose diagnoses share similar characteristics. (Van Lent, 2005)

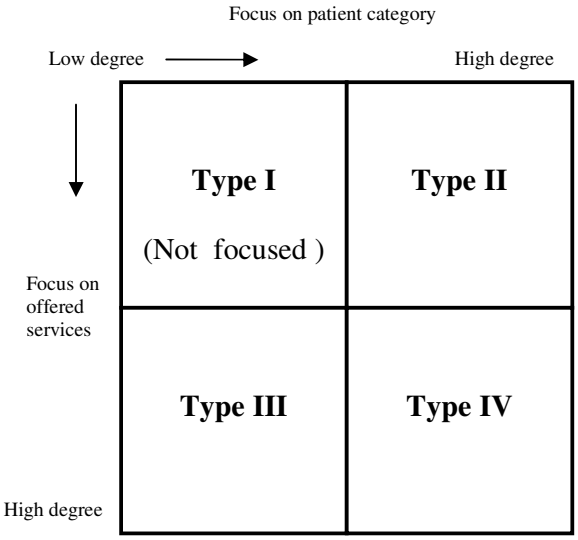

Figure 3: Categorization of focused hospitals (Van Lent, 2005)

Type I cannot be a focused factory, since it does not focus on either patients or offered services. Type II organizations have a high focus on a patient category. This concerns the whole process a patient undergoes after arrival at the hospital. Type III organizations have a high focus on the offered services. These organizations deal with a certain activity that is performed in the same stage of the process. The type IV hospitals perform a certain activity in the same stage of the process for a specific patient category. (Van Lent, 2005) This is illustrated in Figure 4.
This classification will be used to determine the degree of focus of the case study hospitals.

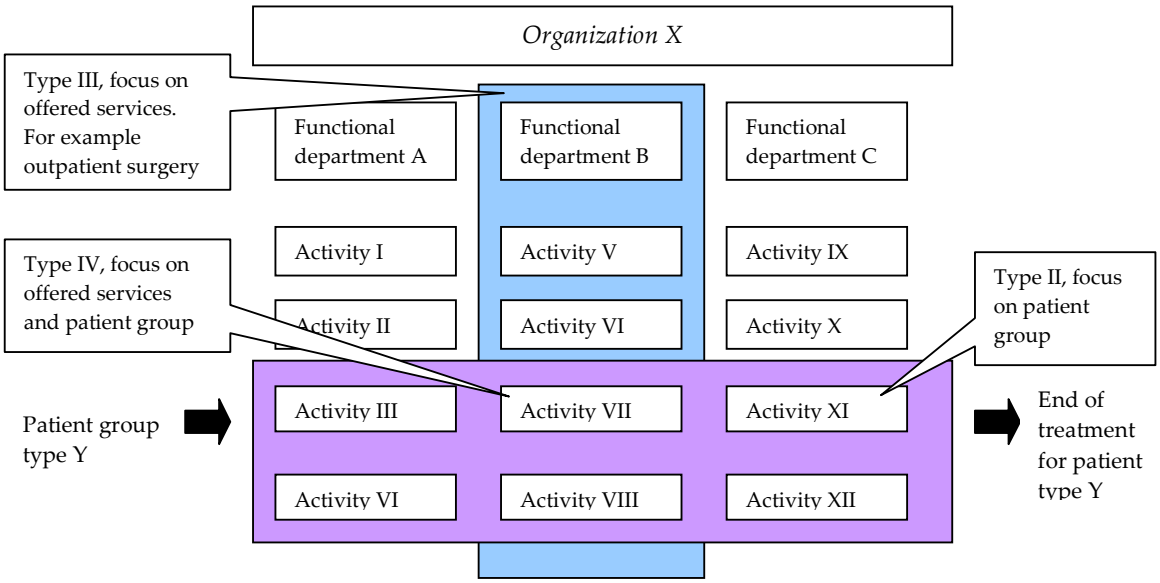

Figure 4: Difference between focus on patient category, on offered services or on both (based on Van Lent, 2005)

Since this research concerns the relation between focused factories and efficiency, it is necessary to define what is meant by efficiency and how it can be measured. Therefore, ways in which efficiency is measured in manufacturing, service organizations and healthcare will be discussed in the following sections.

3.2 Efficiency in manufacturing

This section handles efficiency measures used in manufacturing. First a general way to measure efficiency is introduced. After that the difference between efficiency and productivity is explained. This is followed by a discussion of different categories of efficiency measures. The last part of the section is spent on an example of an efficiency measure used in manufacturing.

Efficiency concerns the internal functioning of an organization. In general it is measured as the ratio of inputs to outputs. (Daft, 2001) The opposite of efficiency is productivity, which is calculated as the ratio of outputs to inputs. (Murdick et al, 1990) See Figure 5.

$$\text{efficiency} = \frac{\text{inputs}}{\text{outputs}}$$

$$\text{productivity} = \frac{\text{outputs}}{\text{inputs}}$$

$$\text{efficiency} = \frac{1}{\text{productivity}}$$

Figure 5: Efficiency and productivity

Currie (1977) indicates that productivity is an overall conception which is difficult to express or to measure. Only when measured as a currency it is possible to

evaluate different mixes of input and output. Murdick et al (1990) suggest the use of indices. The results of these indices over time can be compared. (Murdick et al, 1990) Productivity can for example be expressed in terms of the output from labour, or from services, or from the capital invested. (Currie, 1977) This conclusion seems applicable to efficiency as well.
This information on efficiency and productivity stems from general bodies of knowledge. Two of the sources are handbooks on management (Murdick, 1990; Daft, 2001), while the third is a handbook that handles different techniques with which the results of departments are measured and evaluated (Currie, 1977).

In Figure 6 different categories of efficiency are presented and described. This is followed by a discussion of the usefulness of these categories of efficiency for the comparison of focused factories.

Categories of efficiency	**Description**
Cost	Expected costs compared to actual costs
Response time	Time processes need to respond to a request for outputs
Productivity	Relationship between work levels and levels of production
Organizational	Amount of resources used to produce a unit of output
Economic	Amount of total resources used to create a unit of output
Operational	Stage at which the maximum potential for al resources is reached
Technical	Amount of inputs used to create outputs; focuses on maximizing the use of resources
	Feasible input/ output vector where it is technologically impossible to increase any output (and/ or reduce any input) without simultaneously reducing another output (and/ or increasing any other input)

Figure 6: Categories of efficiency (Currie, 1977; Daft, 2001; (Ruggiero, 2000; Harrison et al, 2004)

Cost efficiency does not seem very useful for this research, since it compares the expected costs to the real costs. It is a measure for how well the costs can be predicted. The response time efficiency, measures the time it takes an organization to respond to a request for products. This could be applied to focused factories, except, that it is not the category of efficiency this research is interested in. The response time of an organization is partly determined by the supply and demand of its products (or services). In Dutch healthcare the supply of services is determined in negotiation with health insurance companies. Since the negotiated supply is less than the actual demand, additional waiting times occur. Therefore, the time it takes a focused factory to deliver their service(s) is partly not determined by the focused factory.
Productivity efficiency measures how much products of a certain level a person with a certain work level can produce. Comparable categories are organizational, economic, operational and technical efficiency, for these concentrate on the number of products that can be produced with a certain amount of input. These last five categories of efficiency can be used in the comparison of focused factories.

Another way to measure efficiency is presented in a handbook on operations management by Slack et al (2001). Therefore, the efficiency measure stems from a general body of knowledge. This measure takes the theoretical capacity of a plant as a starting point. This is the maximum number of products a plant can produce in a certain time period. The production will be less due to planable activities like changeovers and maintenance. The remaining capacity is called the effective capacity. The production may also be disturbed by

non-planable factors like quality problems, machine breakdowns and absenteeism. The number of products that is really produced is called the actual output. The efficiency of a plant is the ratio of the actual output and the effective capacity. This is also shown in Figure 7.

theoretical capacity =	maximum number of products in a time period
effective capacity =	theoretical capacity – number of products not produced due to planable activities
actual output =	effective capacity – number of products not produced due to non-planable activities
efficiency (productivity) =	$\frac{\text{actual output}}{\text{effective capacity}}$

Figure 7: Efficiency measure according to Slack et al (2001)

It is possible to consider the effective capacity (Slack et al, 2001) as the input of the process, because it determines the number of products that can be produced. In that case the efficiency measure of Slack et al (2001) calculates the ratio of outputs to inputs. This means that the efficiency measure by Slack is not really a measure for efficiency, but rather for productivity.

Based on the different measures for efficiency in manufacturing discussed, we conclude, that efficiency is calculated by the ratio of the inputs and outputs of a process. It is possible to express efficiency as currency, or define indices that measure an aspect of efficiency.

3.3 Efficiency in service organizations

In the previous section efficiency measures that are used in manufacturing plants were described. This section deals with efficiency measures used in service organizations. Two main differences between manufacturing and service organizations are distinguished. The first is that in most service organizations the 'product' is made in contact with the client. The second is that 'products' that are not sold cannot be stored. (Daft, 2001)

Schmenner (1988) refers to a measure for the potential facility efficiency formulated by Chase. Figure 8 shows this formula, that is based on the ratio of the customer contact time and the service creation time.

$$\text{potential facility efficiency} = 1 - \frac{\text{customer contact time}}{\text{service creation time}}$$

Figure 8: Measure for potential facility efficiency according to Schmenner (1988) The service creation time refers to the work process involved in producing the service itself.

However, Schmenner (1988) is dissatisfied with this measure. To his opinion, customer contact time does not completely capture what is challenging about service sector management. Service organizations should be categorized based on two dimensions. The first is the degree of labour intensity. The second is the degree to which the costumer interacts with the service and to which the service is customized for the customer. The

categories and examples of types of organizations distinguished by Schmenner (1988) are presented in Figure 9. For each of these categories the efficiency should be calculated in a different way. Schmenner (1988) does not explain how these efficiency calculations should differ.

		Degree of interaction and customization	
		Low	High
Degree of labour intensity	Low	**Service factory** -airlines -trucking -hotels -resorts and recreation	**Service shops** -hospitals -auto repair
	High	**Mass services** -retailing -wholesaling -schools	**Professional services** -doctors -lawyers -accountants -architects

Figure 9: The Service Process Matrix (Schmenner, 1988)

Instead, Schmenner (1988) gives examples of efficiency measures that can be used in different situations. Many services with a limited capacity normally use the percentage of capacity sold as a measure for operational efficiency. In other organizations the employee's time is often limited. Then the number of billable hours can be used as a measure for operational efficiency. In organizations with both a limited capacity and limited employee's time, efficiency can be measured by the utilization of both equipment and labour.
Schmenner (1988) also describes the price efficiency rate and the asset revenue-generating efficiency. The formulas for these forms of efficiency are presented in Figure 10.

operational efficiency =	capacity sold
price efficiency =	average price obtained per unit of service / maximum potential price per unit of service
asset revenue-generating efficiency =	operational efficiency * price efficiency

Figure 10: Measures for efficiency in services according to Schmenner (1988)

Based on the measures discussed, we conclude, that the operational efficiency is calculated by the capacity use of personnel and equipment.

3.4 Efficiency in hospitals

In the previous section efficiency measures that are used in service organizations were discussed. This section studies the measures that are used in hospitals. The section contains four different categories of measures. In the first section the measures that only compare inputs to outputs are discussed. The second section deals with a model, which relates the inputs and outputs to the hospital care process. In the third section a model for efficiency is given, that is not directly linked to hospital input and output. In the fourth section a model to measure the performance of hospitals is given. All these models are described and the usefulness for this research is discussed.

3.4.1 Comparing input and output

Chilingerian et al (2004) describe hospital care as a process consisting of two parts. Managers control one part and physicians the other. The output of the process controlled by managers forms the input for the process controlled by physicians. Since managers control only part of the hospital care process, only the efficiency achieved within this part can be attributed to them. This efficiency is called managerial efficiency. Like the managers, the physicians can only be held responsible for the efficiency they achieve within their part. This efficiency is called clinical efficiency. These two types of efficiency can be added to the types described by Harrison (2004) in section 3.2. The inputs and outputs that can be measured for managers and physicians are mentioned in Figure 11.

Part 1: Manager Controlled	
Managerial inputs	**Intermediate outputs**
FTE Registered Nurses	Quantity of ICU, CCU, PCU Patient Days
FTE Licensed Nurses	Hours of Routine Nursing Care
Other Clinical Labour	Quantity of Treatment Hours (OR, Therapy)
FTE Management and Support Staff	Quantity of Lab and Diagnostic Tests
Medical Supplies and Drug expenses	Hours of Counseling Services
Other Supply Expenditures	Drugs Dispensed
Misc. Contracts	
Capital and Fixed Costs	

Part 2: Physician Controlled	
Clinical inputs	**Clinical outputs**
Quantity of ICU, CCU, PCU patient days	Quantity of Patients Diagnosed, treated & Discharged with Satisfactory Outcomes by Severity Group within Diagnosis 1, Dx, 2, … DXn
Hours of Routine Nursing Care	
Quantity of Treatment Hours (OR, Therapy)	
Quantity of Lab and Diagnostic Tests	Quantity of Individuals Trained by the Speciality
Hours of Counseling	Research Grants & Publications
Drugs Utilized	

Figure 11: Illustration of the in- and outputs managers and physicians control (Chilingerian et al, 2004)

The division Chillingerian et al (2004) made between managerial and clinical efficiency could be useful for this research. It gives us the opportunity to make a distinction between the contributions of these two groups on the efficiency of a hospital. The input and output measures of the capacity use of personnel and equipment, can be used in this research. Measuring the use of medication seems less applicable to an orthopaedic department.
Examples of comparable models were found by Chilingerian (2004). These models do not make a distinction between managerial and clinical efficiency, but use similar inputs and outputs. Therefore, these models will not be discussed any further.

3.4.2 Relating input and output to the hospital care process

Schuring et al (2004) developed a benchmarking instrument for comparing the performance of Dutch hospitals. This model is discussed, although it measures the performance of hospitals and not their efficiency. The model divides hospital care delivery in a number of core tasks. For several of these tasks performance indicators were formulated. Figure 12 shows the measures used by Schuring et al (2004).

core task	inputs	outputs
diagnosis	first outpatient clinic visits	number of radiology performances per specialism
medical examination	total MRI-capacity	MRI-production (€)
	total CT capacity	CT production (€)
	FTE radiology personnel	radiology production (€)
surgical treatment	realized operating time	operating room production (€)
	theoretical available operating time	operating room production (€)
	FTE supporting operating room personnel	operating room production (€)
nursing	expected nursing time days	real nursing time days
	percentage of potential day care	
core task exceeding indicators	number of first outpatient clinic visits	number of physical visits per specialism
	percentage of absenteeism	

Figure 12: Input and output measures for hospital core tasks (Schuring et al, 2004)

The outputs of these measures consist for a large part of financial components. Therefore, Schuring et al (2004) probably developed this measure together with the financial departments of the seven cooperating hospitals. Financial measures do not seem very useful for this research. Since, it will be difficult to determine the exact price of a (part of a) treatment.

In the previous section we concluded that the efficiency can be calculated by the capacity of the equipment used and personnel working in the focused factory. Therefore, the number of employees in FTE can be a useful input measure. The same argument applies for the capacity of the CT, MRI and the operating room department. As far as these measures can be applied to focused factories.

Furthermore, the number of first outpatient clinic visits can be used as a measure for the number of unique patients that visit the hospital during a year. Although this measure may not be very accurate for hospitals that are growing or declining fast, it can be related to the number of activities or operations performed.

3.4.3 Defining measures for efficiency

Veillard et al (2005) quote a definition of hospital efficiency used by the WHO: "Efficiency is a hospital's optimal use of inputs to yield maximal outputs, given its available resources". This corresponds with the descriptions of technical and operational efficiency of Harrison et al (2004). Furthermore, Veillard et al (2005) made a hospital performance assessment framework for the WHO Regional Office for Europe. A part of this framework measures hospital efficiency. This part of the framework is displayed in Figure 13.

measures for efficiency	indicator	numerator	denominator
appropriateness of service	day surgery, for selected tracer procedures	total number of patients undergoing a tracer procedure who have it performed in the day procedure facility	-
productivity	length of stay, for selected tracers	median length of stay in number of days of hospitalization. Day of admission and discharge count as 1 day.	-
use of capacity	inventory in stock, for pharmaceuticals	total value of inventory at the end of the year for pharmaceuticals	total expenditures for pharmaceuticals during the year / 365
	intensity of surgical theatre use	number of patient hours under anaesthesia	number of theatres * 24 hours.

Figure 13: Measures for efficiency by Veillard et al (2005)

From the efficiency in service organizations we learned, that efficiency is determined by the capacity use of personnel and equipment. From the perspective of 'use of capacity' the pharmaceuticals utilization does not seem applicable on orthopaedic departments. The time patients are under anaesthesia however, can be an indicator for the length of operations and can be used as such in this research. The indicators of the other efficiency measures, measure the capacity use of day surgery facilities and hospital beds (length of stay). These measures may be used as well.

3.4.4 Modelling the hospital organization

Waring (2000) developed a model to measure the organizational performance of a NHS-hospital. Although the model does not measure the efficiency of a hospital, its structure may be useful for this research.

The model consists of four parts: 'Inputs', 'Structure', 'Processes' and 'Outcomes'. The structure of an organization includes all the internal characteristics. These characteristics shape it and determine how it operates. Organizational processes are the factors directly or indirectly involved in achieving the organizational goals. The model is shown in Figure 14.

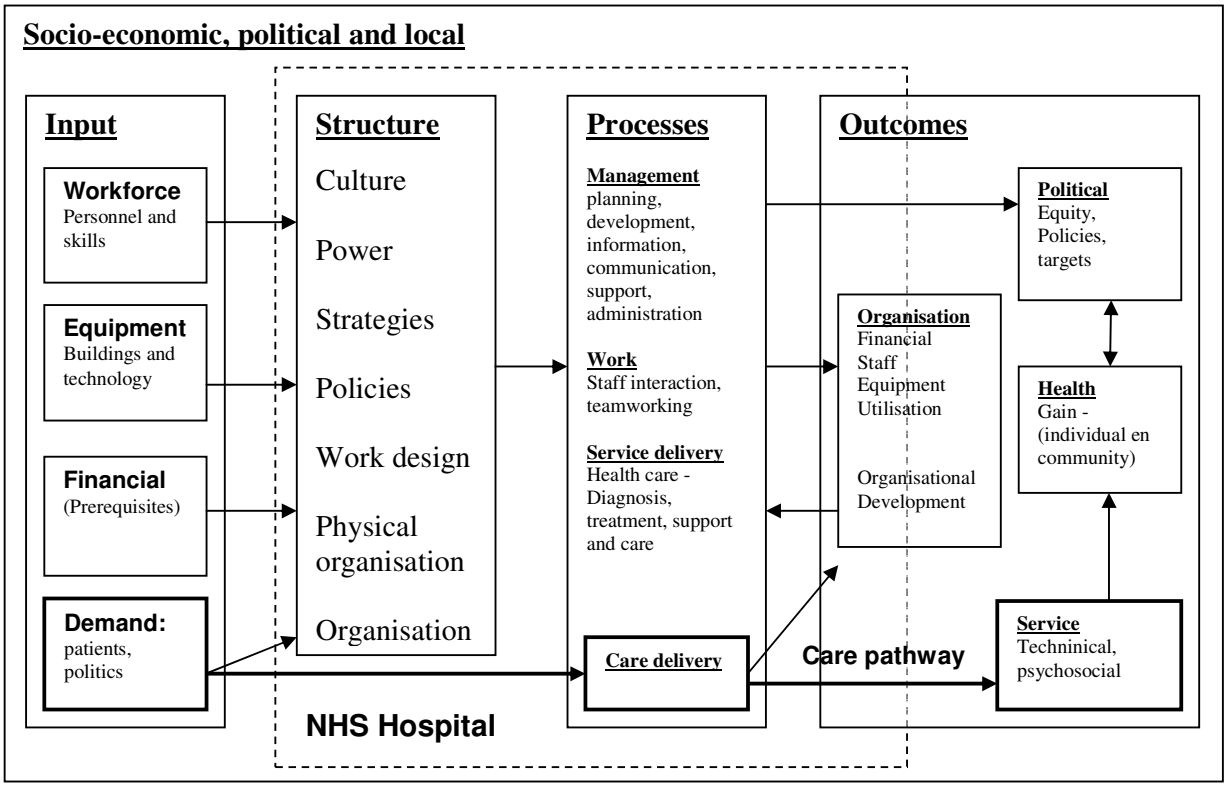

Figure 14: Basic organizational performance model of a NHS hospital by Waring (2000)

A disadvantage of the model of Waring (2000) is that it is developed to compare hospitals on a macro level. Therefore, not all the 'outcomes' are useful. The outputs that might be useful for this research, belong to the sub-category 'organization'.

3.4.5 Conclusion

In this section three categories of frameworks for efficiency measurement in hospitals were discussed. The measures in the first category compare inputs to outputs, for instance the efficiency measures used in manufacturing. The measures in the second category do the same, however now the measures are related to the processes in a hospital. Different measures in these two categories compare different inputs and outputs. Similar to the efficiency measures in service organizations most of the measures compare the capacity use of personnel and equipment. The third category makes use of indicators for efficiency. The last category contains a hospital performance measurement model. This is discussed for its structure.

We conclude, that hospital efficiency can be measured in many different ways. None of the measures discussed can be used entirely for the efficiency measurement in focused factories. Not all of the indicators are applicable to focused factories. Therefore, we will develop such efficiency measure. This can only be done after discussing the relation between focus and efficiency.

3.5 Relation focus and efficiency

In the previous sections focused factories and efficiency were explained. Furthermore, we described how efficiency can be measured in manufacturing, service and healthcare organizations. In this section the relation between focus and efficiency will be discussed.

Hypotheses for this research will be formulated based on what other authors wrote about the relation between focus and efficiency. In this section we use Daft's (2001) definition of efficiency as introduced in section 3.2. According to this definition, efficiency is the ratio of inputs and outputs. (Daft, 2001) An organization is assumed to be more efficient than an other, if that first organization produces more output with the same amount of input.

Skinner (1974) did research on focused factories in approximately 50 plants in six industries. He stated that a plant that focuses on a narrow product mix for a particular market will outperform a conventional plant that produces more, different products for different markets. The costs of the focused plant are presumed to be lower, since the equipment, supporting systems and procedures can concentrate on a limited task for one set of customers. Moreover, simplicity, repetition, experience and homogeneity of tasks cause employees to become more competent for their set of tasks. This is generally assumed.

Bozarth et al (1997) performed a survey of 24 North Carolina plants in the automobile industry. Of the plants surveyed, 20 were visited and interviews were held. The plants performance was measured with the preference of the customer in mind. Therefore, performance was divided in six competitive priorities: conformance quality, delivery reliability, cost, delivery speed, design capability and product range. The authors also made a distinction between market requirements focus and manufacturing characteristics focus. For the market requirements focus Bozarth et al (1997) found results that show that increases in the number of product lines or major customers had a significant negative impact on performance. The same applies to the variability in customers' deliver reliability and design requirements. For the manufacturing focus, higher levels of focus and work cell/ plant-within-a-plant characteristics were associated with better manufacturing performance. Based on these findings the first two hypotheses for this research are formulated.

Hypothesis 1: focussing on a limited number of patient categories leads to a higher efficiency.

Hypothesis 2: focussing on a limited number of services leads to a higher efficiency.

Suarez et al (1996) studied 31 printed circuit board plants. Their results indicate that plants that are more focused will lose the flexibility to innovate. As a result of that the authors assume these plants will be more vulnerable for demand fluctuations. In the long run this will make it difficult to utilize the maximum capacity. This leads to the third hypothesis.

Hypothesis 3: If all else stays stable, there is a maximum on the efficiency increase that a hospital can achieve through focus.

An organization for example is limited by the building it is situated in. Besides that the hospital can become focused on a very small category of patients. Trying to reach them could lead to higher costs, or the patient base can become too small in relation to the overhead costs. This will both make the hospital less efficient. A radical change in for example building or focus will change the efficiency. This is illustrated in Figure 15.

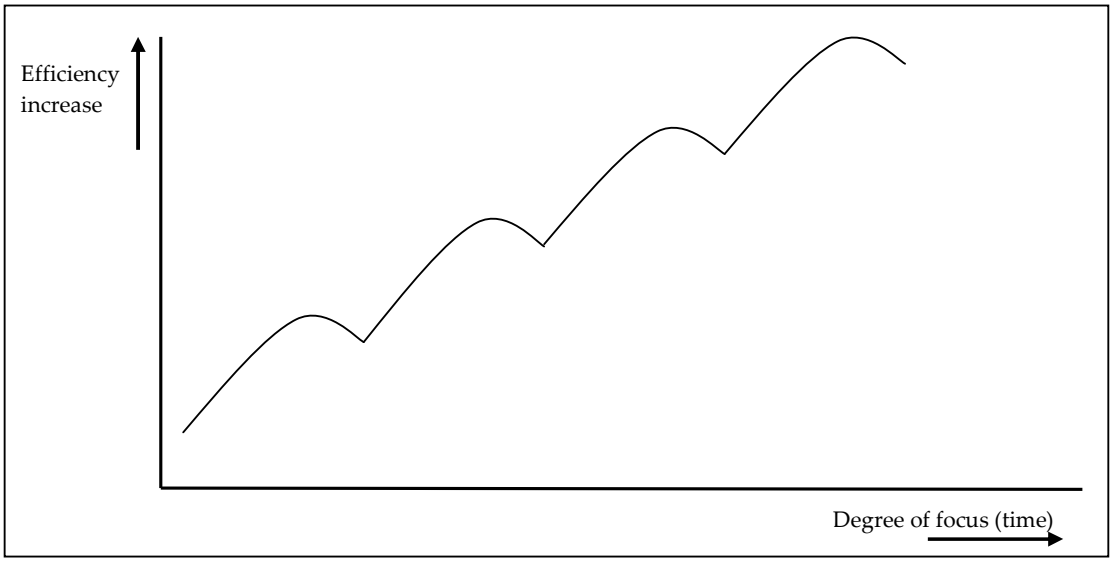

Figure 15: Hypothesized relation between degree of focus over time and efficiency increase (based on (Suarez et al, 1996), 'Performance improvement' (Slack et al, 2001) and 'Organizational life cycle' (Daft, 2001)

The relation between focus and efficiency is not only the subject of research in manufacturing, but in healthcare as well. McLaughlin et al (1995) compared 119 outpatient surgery clinics. These clinics were divided in three categories: freestanding (68), hospital owned with separate operating rooms (38) and hospital owned which are integrated with the inpatient surgery units and share the same operating rooms (13).
For this research the comparison of the two categories of hospital owned clinics seems relevant. The outpatient clinics with their own operating rooms scored significantly better on for example 'scheduling efficiency', 'low overhead', 'low overall costs', than the outpatient clinics that are integrated in the inpatient surgery units. When this is applied to orthopaedic patients, it leads to the following hypothesis.

Hypothesis 4: *Orthopaedic departments that separate their inpatient and outpatient activities will be more efficient.*

Based on the different hypotheses presented in this section the following combined hypothesis is formulated for this research.

Combined hypothesis: *Focussing on patients or services - like splitting inpatient and outpatient activities - leads to a higher efficiency, although, if all else stays stable, there is a maximum efficiency increase a hospital can achieve.*

3.6 Conclusion

This chapter started with the recent insights on focused factories. A categorization in three types of focused factories was presented. Focused factories were categorized based a focus on patient category and a focus on offered services.
Furthermore, efficiency measures used in manufacturing, service organizations and hospitals were discussed. From the efficiency measures used in manufacturing we conclude, that efficiency is measured as the ratio of inputs and outputs. These ratios can be measured in a currency or by defining indices. The capacity use of equipment and personnel are measures

of efficiency used in service organizations. The efficiency in hospitals is measured in ways similar to manufacturing and service organizations. A measure that immediately can be applied to efficiency in the focused factories was not found.
In the last section a hypothesis for the relation between focus and efficiency in hospitals was formulated. The next chapter introduces the processes in an orthopaedic department, the differences between such a department and a joint care unit and discusses the protocol that will be used during the case studies.

4 Processes, comparison and case study protocol

In this research an orthopaedic hospital will be compared with an orthopaedic department of a general hospital. Within this comparison also an individual treatment is compared with a joint care treatment. Before these comparisons are made, the first section of this chapter will introduce the general processes taking place in an orthopaedic hospital and department. The second section introduces the differences between an individual and a joint care treatment. In section three is explains the reasons for the comparisons in this research. The fourth section discusses the case study protocol, that has been developed.

4.1 Orthopaedic processes

This section starts with a short introduction on orthopaedics. After this the most important processes in an orthopaedic hospital or department are discussed.

Orthopaedics concerns curing parts of the body that are necessary for support and motion. This means the recovery of function of bones, joints and muscles. (Van der Linden et al, 1991)

Diagnostic phase

The orthopaedic process starts with the anamnesis, after a patient with a complaint is referred to a hospital by a general practitioner. This anamnesis is often combined with a general orthopaedic examination. The patient is examined on changes in shape, swelling and arthrosis. Moreover, it is possible to use diagnostic equipment and tests to find the cause of the complaint. For example taking two sided X-rays, making an MRI-scan, or taking blood or urine samples. If necessary the anamnesis is expanded after these tests are performed. Otherwise the physician determines a diagnosis. Based on this diagnosis a treatment decision is made. (Van der Linden et al, 1991)

'Operation' phase

The choice is made between a conservative treatment or an operation. Examples of conservative treatments are physiotherapy, medication and external prosthesis. An operation means surgery on the injured part of the patients body. (Van der Linden et al, 1991)

Post operative phase

After surgery a patient can be hospitalized for a number of days. During the year after the patient has been discharged, the patient may need to return to the hospital three or four times for a check-up.

In this research we look at the whole system, for patients needing surgery. The most important phases are summarized in Figure 16.

Processes	*Performed by*
Diagnostic phase	
Anamnesis	Medical specialists
Diagnostic tests	X-ray, MRI-department employees
Consult	Medical specialists
Operation phase	
Surgery	Operating medical specialists
Post operative phase	
Inpatient	Nurses
Consults	Medical specialists
Support	
Support + overhead	Managers, cleaners, warehousing employees, secretaries

Figure 16: Processes in an orthopaedic department

4.2 Joint care processes

'Joint care' is a type of care for patients who have a knee or hip replacement. Important in joint care is standardization of pre surgical and post surgical protocols among the medical specialists and participating facilities. Also a sense of teamwork and camaraderie among the patients is promoted. (Teeny et al, 2005)
Just as the individual orthopaedic treatment the joint care treatment consists of a diagnostic, operation, post operative phase. Differences occur in the organization of and between these phases. This section discusses the differences between an individual orthopaedic treatment and a joint care process.

Between the diagnostic and operation phase
In the diagnostic phase it is decided if a patient needs surgery. At the same moment is decided whether this is done in joint care, or in an individual setting. A patient who will be operated in joint care receives additional information through educational videotapes, brochures and displays. At the outpatient clinic patients watch a video about their disease and treatment. Patients also receive a manual that provides information and guidance for each phase of their treatment and recovery process.
When hospitalized, a patient and his family watch a video about what can be expected the first 24 to 48 hours after operation. At that moment patients are told they are not ill, they only have bad joints. (Steel III et al, 2000)

Operation phase
In the operation phase there are several differences between individual and joint care operations. At the day of the operation joint care patients are admitted as part of a small group. A key component of joint care is standardization of surgery schedules and procedures. This is done to make it possible, that more patients with similar injuries are operated successively. A consequence of that, operating rooms, anaesthesiologists and surgical teams can be used consistently. (Teeny et al, 2005)

In most hospitals with a joint care unit, the joint care patients are only operated on Monday or Tuesday. For instance two or three joint care patients are operated simultaneously. These patients rehabilitate as a group (post operative phase). On Fridays this group of patients is discharged. (Steel III et al, 2000)

Post operative phase
After the operations, the patients are hospitalized at a separate unit of the hospital (the joint care unit). At this unit the patients have a bed and a living room with comfortable chairs. Joint care patients are stimulated to wear everyday clothes in stead of hospital gowns. (Steel III et al, 2000)
Joint care protocols concentrate on eliminating aspects of post operative care that often limit early post operative ambulation. For instance joint care patients´ urinary catheters are removed after a maximum of 24 hours, while a maximum of 48 hours was usual before joint care was introduced. (Teeny et al, 2005)
At the joint care unit patients participate in therapy and exercise as a group. The patients motivate each other during the exercise sessions and reduce each others anxieties and concerns. The ambulation therapy has been turned into a fun event. Also a friend or family member of the patient is educated as a ´coach´. This person is allowed to assist the patient during exercise and therapy. (Steel III et al, 2000)
During the week the hospital organizes other group activities, that do not directly have a health related goal. At their discharge on Friday the patients and their coaches view a video on for instance wound care and possible complications. (Steel III et al, 2000)

4.3 Why this comparison?

This section presents the reasons for the comparison between a joint care treatment and an individual treatment.
This research is interested in the efficiency of orthopaedic processes. For that reason two case studies will be performed. It is necessary to measure the efficiency of (at least) two hospitals or departments, since efficiency scores are always presented compared to some other organization, or compared with historic efficiency scores.
'Efficiency' also suggests the organizations, that have been subject of research, or their type of organization have to be ranked. In this research, that will not be done. It is not possible to draw general conclusions based on two case studies.
Therefore, the results of the case studies will only be used to support the hypothesis on the relation between focus and efficiency as presented in the previous chapter.

4.4 Case study protocol

For this research a case study protocol has been formulated. This section presents the choices that have been made regarding the case studies in the hospitals. The protocol can be found in appendix A. It consists of four parts.

Part one: Comparing general characteristics
Part one contains indicators for the comparison of the complete hospitals.

Part two: Measuring focus
Part two contains a questionnaire with which the degree of focus can be measured. This questionnaire was originally developed by Van Lent (2005) and adapted for this research.

Part three: Process alignment
Part three presents a list of questions with which the process alignment of organizations is measured. This list was also developed by Van Lent (2005), but for this research some minor adaptations were made. Differences between the objects of research made these adaptations necessary.

Part four: Efficiency measures
Based on the conclusions of chapter 3, a new set of efficiency measures is developed. These measures are based on the model of Waring (2000) (introduced in section 3.4). Although, this model is meant for the comparison of the performance of complete NHS-hospitals, we assume, that the model is general enough to be applied to non-NHS hospitals. Moreover, this research requires efficiency measures on a departmental level. Since the model of Waring (2000) measures at hospital level, the model needs to be adapted for measuring the capacity use of hospital departments. Figure 20 illustrates the parts of the model of Waring (2000) that will be used in this research. The adaptations will be discussed in this section.

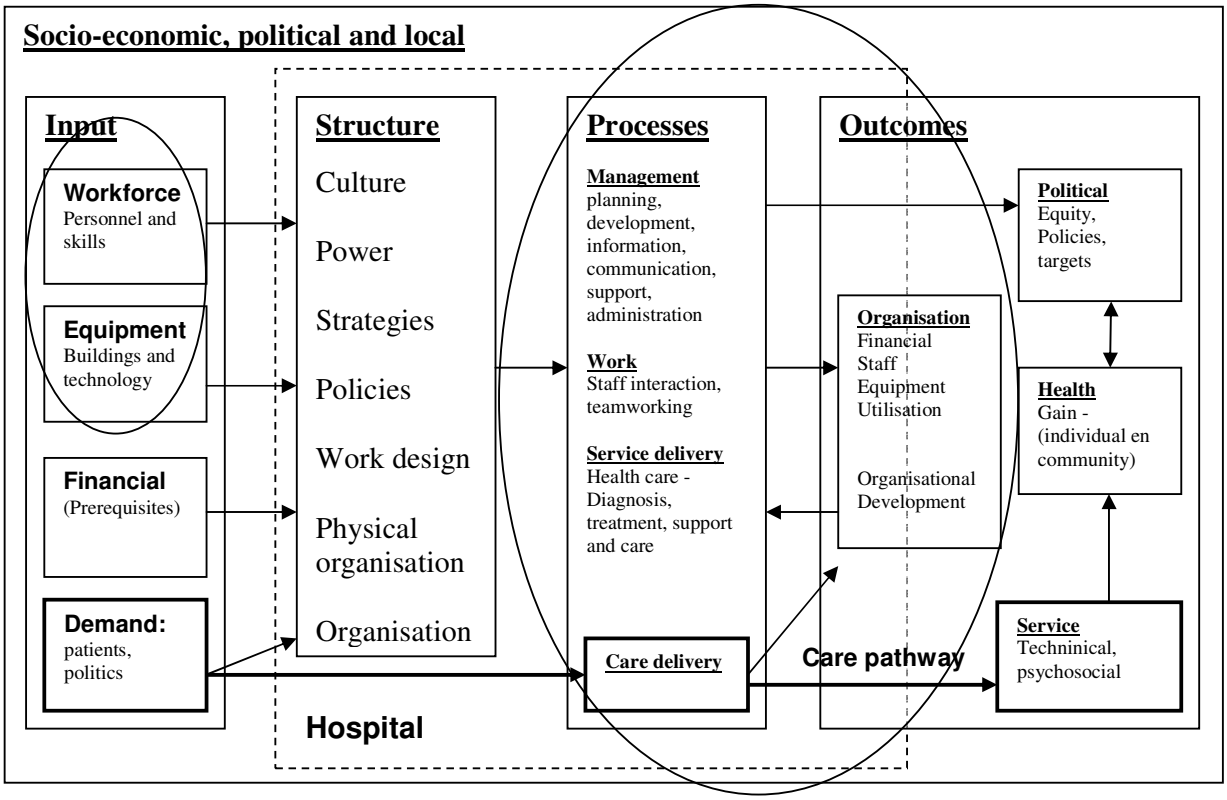

Figure 17: Basic organizational performance model of a (NHS) hospital by Waring (2000), the ellipses contain the parts of the model relevant in this research.

Not all the 'inputs' from the model of Waring (2000) will be used. Since efficiency is measured as the capacity use of personnel and equipment, only the 'workforce' and 'equipment' are of interest for this research. The time the personnel and equipment are scheduled for focused factory patients is measured.
For the outputs not all the 'outcomes' from the model of Waring (2000) can be used. Most of the 'outcomes' regard the entire hospital. Only the measures in the sub-category 'organization' are applicable.

For these measures the results of the output of the ´processes´ are used. In this research we study the service delivery according to the phases described in Figure 16 (diagnostic, operation, post operative, support). Only output of activities performed for the focused factory will be measured. The capacity use is calculated as the ratio of personnel or equipment and the output. The exact efficiency measures are in part four of appendix A.
The category 'structure' of Waring (2000) is used to generate explanations for the differences between the efficiency of the hospital processes.

5 Results hospital 1

This chapter presents the results of the case study in hospital 1. In the first section the hospital is generally introduced. In the second section the focus scores of the orthopaedic department and the joint care unit are determined. In the third section the remaining process alignment results are discussed. The fourth and fifth section present the production results per year and the efficiency results of the hospital.

5.1 Hospital introduction

Hospital 1 is a Dutch general hospital. The orthopaedic department of hospital 1 has a joint care unit. Most of its patients are referred to this hospital by a general practitioner. Hospital 1 has four locations (labelled: A-D). At locations A and C orthopaedic patients are operated. The joint care unit is situated at location A. What we call 'the orthopaedic department' is not really one department. It is more a cooperation of several units. Nevertheless, we call it a department.

Staff

In 2005 hospital 1 had a total number of 2138 FTE employees. Figure 18 shows the number of employees of the relevant departments. One FTE corresponds with one employee working 36 hours in one week.

Type of employee	non supporting (FTE)	supporting (FTE)
Radiologists	12	
X-ray department employees	93	
Operating room assistants	61,5	
Anaesthetists	10	
Anaesthetic assistants	32,3	
Orthopaedic inpatient nurses	33,5	
Other orthopaedic inpatient employees		11,8
Orthopaedic day care nurses	3,1	
Supporting department's and management employees		657,2
Total	**245,4**	**669**

Figure 18: Number of other employees of relevant departments of hospital 1.

The total number of medical specialist that worked in hospital 1 in 2005 was 174 FTE. The medical specialists in hospital 1 are divided in groups based on their specialty. The orthopaedic specialty group consists of 6,9 FTE orthopaedic medical specialists. Each orthopaedic medical specialist has several fields of interest. Six of them operate knee patients. Figure 19 presents information on the number of orthopaedic medical specialists, fellows, interns and nurse practitioners. In case of the medical specialists and interns one FTE corresponds with one person working 45 hours in one week. For nurse practitioners one FTE corresponds with one person working 36 hours in one week.

Type of employee	Orthopaedic department (FTE)	Joint care unit (FTE)
Orthopaedics (MD)	6,9	5,9
Fellows	0	-
Interns	1,0	-
Nurse Practitioners	1,0	-

Figure 19: Number of medical specialists hospital 1 and the joint care unit of hospital 1. (Source: interview hospital 1.)

In Figure 20 the percentage of time the medical specialists, fellows and interns work at the outpatient clinic and in the operating room are presented, just as the time they spend on administrative duties and other tasks.

Type of employee	Outpatient clinic (%)	Operating room (%)	Administrative duties (%)	Other (%)	Total (%)
Medical specialists	40	40	10	10	100
Interns	80	0	20	0	100
Interns without direct supervision	40	0	20	0	60

Figure 20: Percentage of time medical specialists, fellows and interns of hospital 1 spend in the outpatient clinic, operating room, on administrative duties and on other tasks. (Source: interview hospital 1.)

For hospital 1 the percentage of temporary contracts could not be retrieved. In the orthopaedic department of hospital 1 this percentage is 1,2%. A majority of the personnel of hospital 1 (73%) works part-time. This also applies to the orthopaedic department (87,5%). The part of a full-time contract, that these employees work, is added to the number of employees in FTE.

	Whole hospital	Orthopaedic department
Percentage of temporary contracts	-	1,2%
Percentage of part-time contracts	73%	87,5%

Figure 21: Percentages of temporary and part-time contracts in hospital 1 and its orthopaedic department. (Source: hospital database hospital 1.)

Resources and partnerships

<u>X-ray-/ MRI-department</u>

The four locations of hospital 1 each have one or three X-ray machines and three locations have one MRI-scanner. The MRI-scanner at location A is more sophisticated, than the MRI-scanners at the other locations. The more complex MRI-scans and X-rays are made at this location (A), while the simpler (mass-production) scans are made at the other locations. The opening times of the X-ray/ MRI-departments for planned X-rays and MRI-scans differ between the three locations.

Location	Opening times	Number of X-ray machines	Number of MRI-scanners	X-ray availability per week (hours)	MRI-scan availability per week (hours)	Type of complexity X-rays and MRI-scans
A	8:00 – 18:30	3	1	157,5	52,5	high
B	8:00 – 17:30	3	1	142,5	47,5	low
C	8:30 – 17:00	1	1	45	45	low
D	8:00 – 12:30	1	0	22,5	0	low
Total:		8	3	367,5	145	

Figure 22: Opening times X-ray departments, number and availability (per week) of X-ray machines and MRI-scanners at the four hospital locations, type of X-rays and MRI-scans made. (Source: interview hospital 1.)

Outpatient clinic

The opening times of the outpatient clinic differ from those of the X-ray/ MRI-department and of the operating room. The orthopaedic outpatient clinics are situated at the locations A and C. The outpatient clinics are opened from 8.00 hours till 16.30 hours. Patients are scheduled from 8.30 till 12.00 hours and from 13.30 till 16.30 hours.

Operating room

Hospital 1 has 14 operating rooms at three locations. Four days of the week 12 operating rooms are used. One day of the week the hospital uses 10 operating rooms. Orthopaedic operations are performed at locations A and C. The operating rooms are opened from 8:00 until 16:00 hours. In location C the recovery department closes at 17:30 hours, in the locations A and B at 18:00 hours. This influences at which time the last operations of a day have to be finished.

The medical specialists have fixed days of the week on which they operate. Each day four operating rooms are used by orthopaedic medical specialists. If an orthopaedic medical specialist is not able to operate, because he, for example, visits a congress, his operating time is allocated to an other orthopaedic medical specialist.

Hospital 1 does not necessarily schedule similar operations sequentially. After a joint care operation a medical specialist sometimes continues with an other type of operation. Between two operations the operating room assistants change tasks. For instance, the employee directly assisting the surgeon in one operation, hands instruments in a second operation and hands materials in a third operation.

Location	Opening times	Operating room availability per week (hours)	Closing times recovery department
A	8:00 - 16:00	160	18:00
B	8:00 - 16:00	160	18:00
C	8:00 - 16:00	144	17:30
D	-	0	-
Total:		464	

Figure 23: Opening times and availability (per week) of the operating rooms and closing times recovery department at the four hospital locations of hospital 1. (Source: interview hospital 1.)

Inpatient clinic and day care

Orthopaedic patients of hospital 1 are hospitalized at locations A and C. At location A the orthopaedic department uses a 26 bed inpatient department and a combination of a 20 bed inpatient (14 beds) and day care (6 beds) department. This combination department closes in the weekend. At this last department also ENT and gynaecologic patients are hospitalized. For orthopaedic patients 12 beds are used. Six of these beds are reserved for joint care patients. These patients are not hospitalized separately from the other patients. The joint care patients also have a living room with six comfortable chairs, this is not available for other patients.

At location C the orthopaedic unit uses a 25 bed inpatient department and a 20 bed day care department. Both departments are used for other patients as well. At location C 4 day care and 6 inpatient beds are reserved for orthopaedic patients. Location C is closed during the weekend.

In Figure 24 the available capacity of hospital 1 per week is summarized.

Type of input	**Orthopaedic department**			**Orthopaedic patients**		
	Quantity	**Days**	**Availability/ week (days)**	**Quantity**	**Days**	**Availability/ week (days)**
Inpatient beds A1	26	7	182	26	7	182
Inpatient beds A2	14	5	70	9	5	45
Inpatient beds C	25	5	125	6	5	30
Total inpatient beds	**65**	**-**	**377**	**41**	**-**	**257**
Joint care beds	6	5	30	6	5	30
Day care beds A2	6	5	30	3	5	15
Day care beds C	20	5	100	4	5	20
Total day care beds	**26**	**-**	**130**	**7**	**-**	**35**

Figure 24: Number of orthopaedic inpatient and day care beds of hospital 1 (per week) and number of beds reserved for orthopaedic patients. (Source: database and interview hospital 1.)

Processes

We will describe the characteristics of the three phases of the patient process as defined in section 4.1 for hospital 1. The diagnostic phase is followed by the treatment phase and the post operative phase.

Diagnostic phase

An orthopaedic patient has to visit the hospital several times before operation. In general orthopaedic patients have X-rays taken before their first outpatient clinic visit. This can be done days or minutes before the outpatient clinic visit. If a medical specialist requires a MRI-scan to diagnose the patient, the patient has to visit the hospital two extra times: one time for the MRI-scan and one time for an outpatient clinic visit. If a MRI-scan is not required, a decision to operate can be made during the first outpatient clinic visit.

After the decision to operate is made, the patient makes an appointment with an anaesthetist and with an orthopaedic consultant. The anaesthetist performs a pre-operative screening of the patient and informs him of the type of anaesthetics that will be used. The orthopaedic consultant informs the patient about the operation, the recovery process and, if necessary,

makes arrangements for the post-hospital care at home, at a revalidation hospital or at a nursing home.
The appointments with the anaesthetist and orthopaedic consultant can be planned on the same day, but the anaesthetists and orthopaedic consultants work at different locations. If the patient rather plans these appointments on separate days, this is possible.

Operation phase
Only joint care patients visit hospital 1 on the Friday afternoon before their operation. They are officially hospitalized this day. The patients get a chance to meet the other joint care patients and see the rooms in which they will be staying. Patients also receive more information about their recovery process from the orthopaedic consultants, physiotherapists and nurses. After this, the patients are send home for the weekend and return to the hospital on Monday or Tuesday, the day of their operation. Other orthopaedic patients are hospitalized the day of their operation.

Post operative phase
The day after the operation the joint care patients start with a group revalidation and physiotherapy program. On the Friday after the operation the group of joint care patients is discharged. Therefore, joint care patients are normally hospitalized for 5 days.
Other orthopaedic patients have individual physiotherapy in stead of group physiotherapy. The time other patients stay in the hospital depends on their injury and the speed of their recovery.

Joint care patients visit hospital 1 between two and five times before operation. Other orthopaedic patients visit the hospital between two and four times before operation.

5.2 Focus results

In this section the focus results of the orthopaedic department and the joint care unit of hospital 1 are discussed. From the joint care unit only the knee patients are considered. The results of the degree of focus on patient group and of the degree of focus on services are presented.

Orthopaedic department
Degree of focus on patient group
The medical specialists of the orthopaedic department of hospital 1 treat patients with injuries that fall in two chapters of the ICD-classification. Patients with diseases of the musculoskeletal system and connective tissue (ICD-chapter XIII) are treated, just as patients that recover from an injury (ICD-chapter XIX). About two third of the blocks in these chapters are treated in the orthopaedic department of hospital 1. The variety in number of patients in each block is perceived as moderate. The patients of the orthopaedic department of hospital 1 fall in the first three classes of the ASA-classification.
Figure 25 shows the degree of focus score on patient group of the orthopaedic department of hospital 1.

Question	Hospital 1	Points	
ICD-classification	two chapters	4	
Variation in patients (ICD-blocks)	about 2/3	1	
Variance in ICD blocks	moderate	2	
ASA-classification	three classes	2	
	Total:	**9**	**56%**

Figure 25: Focus on patient group results, orthopaedic department hospital 1.

The orthopaedic department of hospital 1 scores 9 points on degree of focus on patient group. This corresponds with a degree of focus score of 56%.This exceeds 50%. Therefore, we consider the orthopaedic department of hospital 1 as focused on patient group.

Degree of focus on services

Since radiology and anaesthesiology are left out of consideration, orthopaedics is the only specialty involved. For this specialty more than three sub-specialties are available, e.g.: knee, hip, shoulder, ankle and foot orthopaedics. The radiology department is a shared resource. No arrangements have been made to divide the available X-ray or MRI-capacity. The orthopaedic department offers surgical treatments and diagnostic services. The surgical treatments consist of between 100 and 250 different procedures. The diagnostic services offered, are physical exams, radiology and lab-tests. Most of the orthopaedic departments patients fall in ASA-class 2. A minority of the department's patients fall in ASA -class 3. Patients in ASA -classes 4 and 5 are not treated in the orthopaedic department of hospital 1. When day-care patients are considered as outpatient patients, about 44% of the patients is outpatient, while 56% of the patients is inpatient. These inpatient patients differ in length of stay. The orthopaedic department rarely treats urgent patients (less than 5%).
Figure 26 shows the degree of focus score on services of the orthopaedic department of hospital 1.

Question	Hospital 1	Points	
Number of involved specialties	orthopaedics	4	
Number of sub-specialties	>3	0	
Radiology department	not arranged	0	
Types of services	surgical and diagnostic	2	
Variety within services	100-250 procedures, 3 diagnostics	2	
ASA-classification	< 50% Asa = 3; 0% Asa > 3	3	
Inpatient / outpatient	56% / 44%	0	
Urgent cases	< 5%	4	
	Total:	**15**	**47%**

Figure 26: Focus on services results, orthopaedic department hospital 1.

The orthopaedic department of hospital 1 scores 15 points on degree of focus on services. This corresponds with a degree of focus score of 47%. This is less than 50%. Therefore, we consider the orthopaedic department of hospital 1 as not focused on services.

Joint care unit

Degree of focus on patient group

The joint care unit of hospital 1 treats patients from one chapter of the ICD-classification. Only patients with diseases of the musculoskeletal system and connective tissue (chapter

XIII) are treated in the joint care unit. This chapter consists of six blocks. Two of these blocks are treated in the joint care unit of hospital 1. The variance between these two blocks is perceived as low. The joint care patients fall in the first three classes of the ASA-classification.
Figure 27 shows the degree of focus score on patient group of the joint care unit of hospital 1.

Question	Hospital 1	Points	
ICD-classification	one chapter	4	
Variation in patients (ICD-blocks)	about 1/3	3	
Variance in ICD blocks	low	3	
ASA-classification	three classes	2	
	Total:	**12**	**75%**

Figure 27: Focus on patient group results, joint care unit hospital 1.

The joint care unit of hospital 1 scores 12 points on degree of focus on patient group. This corresponds with a degree of focus score of 75%. This exceeds 50%. Therefore, we consider the joint care unit of hospital 1 as focused on patient group.

Degree of focus on services
One specialty (orthopaedics) and two sub-specialties (knee and hip) are involved in the joint care unit of hospital 1. No special arrangements are made at the radiology department for focused factory patients. The diagnostics are not part of the joint care unit. Therefore, surgical treatments are the only type of services involved in the joint care unit of hospital 1. The variety of surgical treatments is small (less than 50 different procedures). Most of the patients fall in ASA-classes 1 and 2, a few in ASA-class 3. All joint care patients are hospitalized for several days. They have a comparable length of stay. No urgent patients are treated in the joint care unit.
Figure 28 shows the degree of focus score on services of the joint care unit of hospital 1.

Question	Hospital 1	Points	
Number of involved specialties	orthopaedics	4	
Number of sub-specialties	two	2	
Radiology department	not arranged	0	
Types of services	surgical	4	
Variety within services	< 50 procedures	4	
ASA-classification	< 50% Asa = 3; 0% Asa > 3	3	
Inpatient / outpatient	> 95% inpatient, similar LOS	4	
Urgent cases	< 5%	4	
	Total:	**25**	**78%**

Figure 28: Focus on services results, joint care unit hospital 1.

The joint care unit of hospital 1 scores 25 points on degree of focus on services. This corresponds with a degree of focus score of 78%. This exceeds 50%. Therefore, we consider the joint care unit of hospital 1 as focused on services.

Types of focus in hospital 1
Based on the scores for focus on patient group and focus on services the orthopaedic department of hospital 1 is classified as a type II focused factory. The joint care unit is classified as a type IV focused factory.

When the scores of the orthopaedic department and the joint care unit of hospital 1 for focus on patient groups and focus on services are placed in the matrix of Figure 3 it gives the following result (see Figure 29).

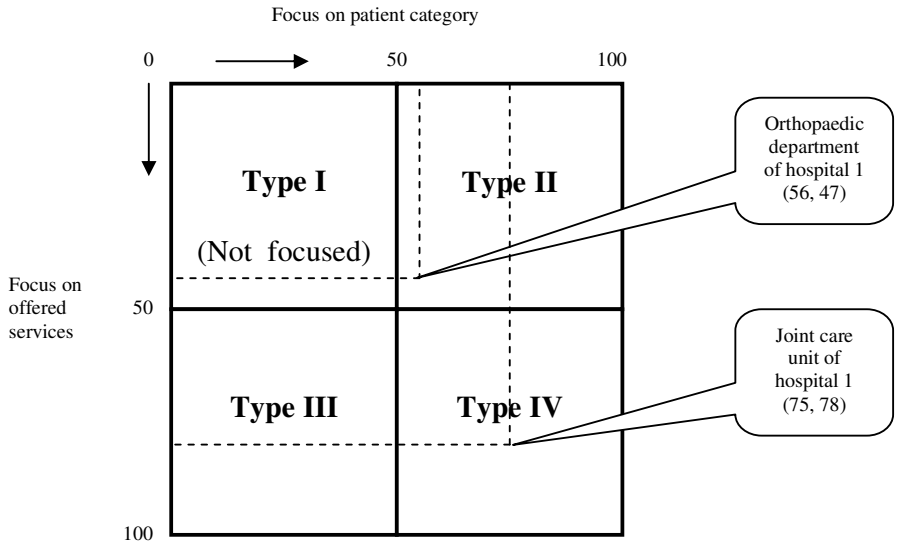

Figure 29: Place of the orthopaedic department and joint care unit of hospital 1 in focus matrix. The orthopaedic department of hospital 1 is classified as a type II focused factory. The joint care unit of hospital 1 is classified as a type IV focused factory.

5.3 Process alignment results

This section contains information on the strategy, policy, leadership, planning, customers and people results of hospital 1. These are discussed, because they give more information on the focus of hospital 1 and these factors may influence the hospital's efficiency.

Strategy, policy and leadership

The strategy, policy and leadership of hospital 1 inform us of the importance of the focused factory for the rest of the organization.

Five years ago the management of hospital 1 made the choice to start the joint care project. At first only hip patients were treated in joint care. Nowadays also knee patients are treated in joint care. Since the recovery process of knee and hip patients is very similar a joint care group can contain both types of patients.

Other orthopaedic focused factories are not likely to be developed in the near future in hospital 1. Focused factories divide the patients in separate groups. Hospital 1 prefers to reorganize the process for the benefit of all its orthopaedic patients. If other focused factories are developed, it is to improve the process for all orthopaedic patients.

According to the manager of the orthopaedic department, the last two years efficiency was more important, than effective, patient-centred or timely care at the orthopaedic inpatient departments. Although these other criteria are important as well, the goal was to treat more patients with less employees. At the orthopaedic outpatient clinic timely care was most important. The access time for the orthopaedic outpatient clinic was much higher than that of other hospitals in the region. To become more competing, the access time of the outpatient

clinic has been reduced by implementing the principles of 'advanced access' (a 'CBO-project').
The information system of hospital 1 contains information on the operational, financial, staff and customer results. Besides this, a tool has been developed which predicts the future operational results.

Planning
A good planning system can raise the production of an organization, while delays will lower it. Therefore, both influence the efficiency. In hospital 1 the planning of the orthopaedic outpatient clinic is separate of that of the operating room and the orthopaedic inpatient departments.

Outpatient clinic
The outpatient clinic planning is made by two outpatient clinic employees. The following variables are used:
- medical specialists
- outpatient clinic employees
- consulting rooms
- time per treatment

At the outpatient clinic different planning routines are used for the different orthopaedic medical specialists. Some medical specialists have a standard time (10 minutes) for each outpatient clinic visit. If it is expected a patient requires more time, it is possible to plan the double time (20 minutes). Other medical specialists differentiate between first consult (15 minutes), return consult (10 minutes) and second opinions (20 minutes).
New patients are scheduled by the planning department. Return consults are planned at the outpatient clinic, just as urgent visits and patients with more complicated injuries.

If a consultation is delayed at the outpatient clinic of hospital 1 nothing special is done. The medical specialist continues, until he has seen al patients. For urgent patients the outpatient clinic has time reserved in its planning. An average of one urgent patient per day visits the outpatient clinic hospital 1.
The average number of 'no shows' at the outpatient clinic used to be four per day. Since hospital 1 started the project 'working without a waiting list', the number of 'no shows' has dropped to less than one per day.

Operating room
The operating room planning is made by an operating room employee, the planning coordinator. Thirteen to six week in advance the planning coordinator decides which medical specialist operates at what times in which operating room. The medical specialist determines how much time is reserved for an operation. Based on this schedule and the reserved times per operation the planning department plans which patient is operated when. Besides that, the orthopaedic consultants give information on the number of implants that can be placed by the different medical specialists. Each orthopaedic medical specialist operates an average of five to seven patients per day. This depends on the type of operations and physical abilities of the medical specialist. Medical specialists are assigned to an operating room.

The variables used when making the planning are:

- Availability of medical specialists
- Qualified operating room personnel
- If necessary, availability of special equipment (for instance: microscope, special room)
- If necessary, availability of an intensive care bed

About 25% of all operation rooms in hospital 1 is delayed. This is 16% for orthopaedic operations. This corresponds with one operation room per day.
When an operation is delayed, the following operation is postponed. Each day around noon the operating room program leader and the medical specialists check if it is necessary to cancel one or more operations. If the expected delay is less than half an hour all planned operations are performed. When the expected delay is more than half an hour one or more operations are cancelled. Operating room managers do not see this as a big problem, since a patient is hospitalized one and a half hour before their operation is scheduled. The percentage of operations that is cancelled within 24 hours before the planned operation time by the hospital is 1,86%. The percentage of operations that is cancelled by patients within 24 hours before the planned operation date is 1,81%.

For urgent operations time is reserved at two operating rooms at the location B from 14:00 till 16:00 hours. Operations that are postponed due to an emergency can be performed then. In general this does not influence orthopaedic operations.

<u>Inpatient departments</u>
The planning of the inpatient department is made by the planning department. This planning is made at the same time as the operating room planning is made. The variables that are used are:

- Number of inpatient beds
- Availability of qualified nurses

Customers
In general, a patient in hospital 1 is operated by the same medical specialist that examined the patient at the outpatient clinic. This makes the organization less flexible in the planning of the operations. Each patient is asked if he objects against an operation by an other medical specialist. If a patient does not object, it is possible the patient is operated by an other medical specialist, for instance if the first medical specialist is ill, or the patient's operation would be cancelled for an other reason.

People results

Absenteeism of personnel due to illness makes an organization less efficient, since, these absent employees need to be replaced. The orthopaedic department of hospital 1 has an absenteeism due to illness percentage of 4,9%. This percentage is lower than the percentage for the whole hospital. Hospital 1 has an absenteeism due to illness percentage of 5,8%.

	Whole hospital	**Orthopaedic department**
Percentage of absenteeism due to illness (excluding pregnancy)	5,8	4,9

Figure 30: Percentages of absenteeism in hospital 1 and its orthopaedic department

5.4 Production results per year

This section contains the production results of hospital 1. The results of the whole hospital, orthopaedic department and the knee patients are presented. The data of the whole hospital comes from the annual report of the year 2005. The data of the orthopaedic department and the knee patients stems from the hospitals information system. The production results are presented per phase of the orthopaedic process..

Diagnostic phase

In Figure 31 'Patients' stands for the number of patients that were treated in hospital 1. The '1st outpatient clinic visits' are the number of first outpatient clinic visits. 'Outpatient clinic visits' is the sum of all outpatient clinic visits. This includes the number of first outpatient clinic visits. The sums of all X-rays taken and MRI-scans made are mentioned behind 'X-rays' and 'MRI-scans'.

Per year	**Hospital**	**Orthopaedics**	**Knee**
Patients	206551	14179	-
1st outpatient clinic visits	160056	10662	-
Outpatient clinic visits	423230	12579	-
X-rays	59600	14900	4670
MRI-scans	8443	1942	1016

Figure 31: Production results diagnostic phase, whole hospital, orthopaedic department and knee patients per year. (Source: annual report 2005 and database hospital 1.)

Operation phase

For the operation phase the number of operations is collected. In case of the knee patients the number of operations is subdivided in the categories ´endoscopies´, ´implants´ and ´other operations´. The numbers of 'other operations' are calculated by subtracting the number of 'endoscopies' and number of 'implants' from the 'operations'. If that data are available, these are presented in Figure 32.

Per year	**Hospital**	**Orthopaedics**	**Knee**
Operations	-	3319	-
Endoscopies	-	-	-
Implants	-	640	235
Other operations	-	-	-

Figure 32: Production results operation phase, whole hospital, orthopaedic department and knee patients per year. (Source: database hospital 1.)

Besides the numbers of these different kind of operations, also the average operating, surgical and preparation time were registered. The same counts for the proportion of operations with complete and partial anaesthesia. These data are presented in Figure 33.

Average…	Orthopaedics	Knee
Operating time (minutes)	78	140
Surgical time (minutes)	48	110
Preparation time (minutes)	30	30
Time operation room used (minutes)	78	140
Complete anaesthesia (%)	25	10
Regional anaesthesia (%)	75	90

Figure 33: Average operating room times and proportion of complete and regional anaesthesia for orthopaedics and knee patients. (Source: interview hospital 1.)

Post operative phase

For the post operative phase the number of ´day-care' treatments, 'nursing days' and 'discharges' are presented in Figure 34. 'Day-care' treatments concern patients that are hospitalized, but do not spend a night in the hospital. 'Nursing days' are the number of days hospitalized patients spend in the hospital. This does not include day-care patients. The number of 'discharges' is the number of hospitalized patients, that were discharged from the hospital, also excluding day-care patients. Besides this, the 'average length of stay' is calculated by the ratio of the 'nursing days' and the number of 'discharges'.

Since in the orthopaedic department of hospital 1 not only orthopaedic patients are treated, in Figure 34 a distinction is made between the orthopaedic department and the orthopaedic patients. The column orthopaedic department contains data of all patients that have been treated in the orthopaedic department. The column orthopaedic patients only contains data of the orthopaedic patients, which is compared with data of orthopaedic patients of hospital 2. Data of knee patients could not be provided.

Per year	Hospital	Orthopaedic department	Orthopaedic patients	Knee
Day-care	33596	7147	1455	-
Nursing days	156364	15344	10433	-
Discharges	27203	4010	1864	-
Average length of stay	*5,7*	*3,8*	*5,6*	-

Figure 34: Production results post operative phase, whole hospital, orthopaedic department, orthopaedic patients and knee patients per year. (Source: annual report 2005 and database hospital 1.)

Support

The overhead costs consist of all costs that are not directly related to patient care. These costs are calculated by the sum of the 'feeding costs', 'hotel costs', 'building and terrain costs' and 'other costs' as mentioned in the annual report of hospital 1. Costs for interest and depreciation are not include in these costs. In 2005 the overhead costs of hospital 1 were 21.962.000 Euro. These overhead costs are not allocated to the different departments.

Per year (*1000 Euro)	Hospital	Orthopaedics
Overhead costs	21.962	-

Figure 35: Production results support phase, whole hospital and orthopaedic department per year. (Source: annual report 2005 hospital 1.)

5.5 Efficiency results

This section presents the input and output of hospital 1 per week in the efficiency measures. With these input and output the efficiency results of hospital 1 are calculated. If necessary these results are converted in better understandable measures.
In the first column of each table "eq" stands for equipment, "pe" for personnel, and "ot" for other. This refers to the background of the efficiency measure.

Diagnosis phase
Figure 36 presents the efficiency results of the X-ray and MRI-department of hospital 1. These measures could only be calculated at the hospital level.

DIAGNOSIS		**efficiency measure**	**Hospital**	
eq	input	x-ray capacity	367,5	hours
	output	x-ray quantity	1146,15	X-rays
	calculation		0,32	hours/ X-ray
	score		**19,2**	**minutes/ X-ray**
eq	input	MRI-capacity	145	hours
	output	MRI-quantity	162,37	MRI-scans
	calculation		0,89	hours/ MRI-scan
	score		**53,6**	**minutes/ MRI-scan**
eq	input	x-ray quantity	1146,15	X-rays
	output	patient quantity	3972,13	patients
	score		**0,29**	**X-rays/ patient**
eq	input	MRI-quantity	162,37	MRI-scans
	output	patient quantity	3972,13	patients
	score		**0,04**	**MRI-scans/ patient**

Figure 36: Efficiency results diagnostic phase, whole hospital (hospital 1) The calculation is based on average input and production results per week.

These efficiency measures show, that every X-ray takes approximately 19 minutes, including the time the X-ray machines are not used. For MRI-scans this is approximately every 54 minutes. An average of 0,29 X-rays per patient are made. This corresponds with an average of 29 X-rays per 100 patients, while an average of 4 MRI-scans per 100 patients are made.
Since the exact number of knee patients is not registered, it is not possible to calculate the number of X-rays and MRI-scans per knee patient. It also is not possible to assign employees to X-ray-machines or MRI-scanners. Therefore, these efficiency measures are left out of consideration.

Orthopaedic medical specialist and interns spend 40% of their time in the outpatient clinic. Figure 37 displays what this means for the average time they have for an outpatient clinic visit.

DIAGNOSIS		**efficiency measure**	**Orthopaedics**	
pe	input	medical specialists	3,56	specialist outpatient time FTE
	output	outpatient clinic visits	447,29	visits
	calculation		0,01	specialist outpatient time FTE/ visit
	score		**21,5**	**minutes/ visit**

Figure 37: Efficiency results diagnostic phase, orthopaedic department (hospital 1). The calculation is based on average input and production results per week.

This average time is 21,5 minutes per orthopaedic outpatient clinic visit. This includes the time they need to prepare the outpatient clinic visit, add data to the patients file and wait for patients that do not show up. Since hospital 1 does not have specific hours for knee patients, it is not possible to calculate the time per knee patient's outpatient clinic visit.

Operation phase

In Figure 38 the efficiency results of the operation room of hospital 1 are presented.

OPERATION		**efficiency measure**	**Hospital**	
eq	input	operation capacity	464	hours
	output	operation quantity	384,62	operations
	calculation		1,21	hour/ operation
	score		**72,4**	**minutes/ operation**
pe	input	FTE OR assistants	61,5	FTE
	output	operation quantity	384,62	operations
	calculation		0,16	FTE/ operation
	score		**345,4**	**minutes/ operation**
pe	input	FTE anaesthetists	10	FTE
	output	operation quantity	384,62	operations
	calculation		0,03	FTE/ operation
	score		**56,2**	**minutes/ operation**
pe	input	FTE anaesthetic assistants	32,3	FTE
	output	operation quantity	384,62	operations
	calculation		0,08	FTE/ operation
	score		**181,4**	**minutes/ operation**

Figure 38: Efficiency results operation phase, whole hospital (hospital 1). The calculation is based on average input and production results per week.

Including the time the operating room is not used, the average time it is used per operation is about 72 minutes. Operating room assistants spend about 345 minutes per operation. This is, because more than one assistant participates in an operation. The same applies to the anaesthetic assistants, who spend about 180 minutes per operation. The anaesthetists work only 56 minutes per operation, because an anaesthetist does not stay with a patient during an operation.

Figure 39 presents the efficiency result of the operation room for orthopaedic and knee patients.

OPERATION		efficiency measure	orthopaedics	knee	
pe	input	medical specialists	2,76	-	specialist operating time FTE
	output	operation quantity	63,83	-	operations
	calculation		0,04	-	specialist operating time FTE/ operation
	score		**116,8**	-	**minutes/ operation**
ot	input	average preparation time	30	30	minutes
	output	average operation time	78	140	minutes
	score	**ratio**	**0,38**	**0,21**	
ot	input	average surgical time	48	110	minutes
	output	average operation time	78	140	minutes
	score	**ratio**	**0,62**	**0,79**	
ot	input	1st outpatient clinic visits	205,04	-	visits
	output	operation quantity	63,83	-	operations
	score		**3,21**	-	**visits/ operation**
ot	input	operation quantity	63,83	-	operations
	output	outpatient clinic visits	447,29	-	visits
	score		**0,14**	-	**operations/ visit**

Figure 39: Efficiency results operation phase, orthopaedic department and knee patients (hospital 1). The calculation is based on average input and production results per week.

Orthopaedic medical specialists spend an average of 40% of their time they in the operation room. This corresponds with an average of 117 minutes per operation, which is more than the average surgical time. The difference is caused by the time necessary to prepare the operations. Another explanation is, that they are unable to make a perfect planning. The time that is not used between two operations or at the end of the day is included in the average time medical specialist spend per operation.

The second and third measures in Figure 39 show the average operation time of a knee patient is almost twice as high as the operation time of an average patient in hospital 1. The average surgical time is more than twice as high. Because of that, the ratio of the average preparation time and the average operation time is almost twice as low for knee patients, than for orthopaedic patients.

Of each 3,2 patients that visit hospital 1 for a first outpatient clinic visit, one is operated. For every orthopaedic patient that is operated in hospital 1 the outpatient clinic is visited seven times (by this operated patient and other non-operated patients).

Since hospital 1 has no specialized hours for knee patients at the outpatient clinic, or at the operation room, some of these efficiency measures could not be calculated for this patient group.

Post operative phase

In Figure 40 the post operative efficiency results are presented of the orthopaedic department, orthopaedic and non-orthopaedic patients of hospital 1. The inpatient and day

care departments that hospitalize orthopaedic patients, also hospitalize patients from other specialties. Therefore, a division is made between the data of all the patients, of the orthopaedic patients and of the non-orthopaedic patients of these (orthopaedic) departments. One of the departments has a combination of inpatient and day care beds. Probably, the beds of this department are used with more flexibility. Therefore, the exact number of inpatient and day care beds can vary per week. This also applies to the number of inpatient and day care nurses. The number of inpatient and day care nurses is allocated to each category of hospital care, based on the percentage of nursing days. This means length of stay (for inpatient) and the number of day care days (for day care). Since the exact number of nurses per patient category (orthopaedic and non orthopaedic) is not registered, the total number of employees has been allocated to the two patient categories, based on the part of the length of stay (for inpatient) and the part of the day care days (for day care).

POST OPERATIVE		**efficiency measure**	**orthopaedic department**	**orthopaedic patients**	**non-orthopaedic patients**	
eq	input	inpatient bed quantity	377	257	120	bed-days
	output	discharge quantity	77,12	35,85	41,27	discharges
	score		**4,89**	**7,17**	**2,91**	**bed-days/ discharge**
pe	input	FTE inpatient nurses	47,5	30,88	16,63	FTE
	output	discharge quantity	77,12	35,85	41,27	discharges
	calculation		0,62	0,86	0,40	FTE/ discharge
	score		**1330,5**	**1860,5**	**870,1**	**minutes/ discharge**
eq	input	day care bed quantity	130	35	95	bed-days
	output	day care patient quantity	137,44	27,98	109,46	discharges
	score		**0,95**	**1,25**	**0,87**	**bed-days/ discharge**
pe	input	FTE day care nurses	17,13	3,43	13,70	FTE
	output	day care patient quantity	137,44	27,98	109,46	discharges
	calculation		0,12	0,12	0,13	FTE/ discharge
	score		**269,2**	**264,5**	**270,4**	**minutes/ discharge**
ot	input	length of stay	296,79	200,63	96,15385	days
	output	discharge quantity	77,12	35,85	41,27	discharges
	score		**3,8**	**5,6**	**2,33**	**days/ discharge**
ot	input	1st outpatient clinic visits	-	205,04	-	visits
	output	outpatient clinic visits	-	447,29	-	visits
	score		**-**	**0,46**	-	**ratio**

Figure 40: Efficiency results post operative phase, orthopaedic department, orthopaedic patients and non-orthopaedic patients (hospital 1). The calculation is based on average input and production results per week.

Including the time the beds of the departments are not used, for each patient 4,9 beds are put into service. The average length of stay per patient is 3,8 days. This corresponds with an occupation rate of 78%. Per inpatient patient an average of 1330 minutes of nursing care is provided. This corresponds with 350 minutes of nursing care a day, which is equal to almost 6 hours.

For day care patients 0,95 bed-days are put into service per patient. In the day care centre each patient receives an average of 270 minutes of care. This corresponds with 4 and a halve hours of care.
These efficiency results do not correspond with the experiences at the inpatient and day care departments of hospital 1. Based on the rules for the number of patients per nurse used in the personnel planning, inpatient patients receive 220 minutes of nursing care and day care patients receive 96 minutes of nursing care. These are minimum numbers and do not include nursing time that is lost due to planning imperfections, personnel absenteeism, etcetera. Nevertheless, there are great differences between the hospital experiences and the presented data.

Including the time the for orthopaedic patients reserved inpatient beds are not used, for each orthopaedic patient 7,2 bed-days are put into service. The average hospitalization time per orthopaedic patient is 5,6 days. This corresponds with an occupation rate of 78%. During hospitalization an orthopaedic patient receives an average of 1860 minutes of nursing care. This corresponds with 330 minutes of nursing care a day, which is equal to 5 and a halve hours.
For orthopaedic day care patients nearly 1,3 bed-days are used per patient. In the day care centre each patient receives an average of 265 minutes of care. This corresponds with nearly 4 and a halve hours of care.

Including the time the for non-orthopaedic patients reserved inpatient beds are not used, for each non-orthopaedic patient 2,9 bed-days are put into service. The average hospitalization time per non-orthopaedic patient is 2,3 days. During hospitalization an non-orthopaedic patient receives an average of 870 minutes of nursing care. This corresponds with 370 minutes of nursing care a day, which is equal to more than 6 hours.
For non-orthopaedic day care patients nearly 0,9 bed-days are used per patient. In the day care centre each patient receives an average of 270 minutes of care. This corresponds with 4 and a halve hours of care.

Since data on the length of stay, number of discharges and number of outpatient clinic visits are not registered specifically for knee patients, we are not able to calculate the efficiency results for this patient group.
Nearly half of all orthopaedic outpatient clinic visits is a first outpatient clinic visit. This means that on average each first outpatient clinic visit is followed by one return consult.

Support

Figure 41 presents the efficiency results of the support phase for hospital 1.

SUPPORT		**efficiency measure**	**Hospital**	
ot	input	overhead costs	422346,2	Euro
	output	patient quantity	3972,13	patient
	score		**106,33**	**Euro/ patient**
ot	input	FTE support personnel	669,0	FTE
	output	patient quantity	3972,13	patient
	score		**0,17**	**FTE/ patient**

Figure 41: Efficiency results support phase, whole hospital (hospital 1). The calculation is based on average input and production results per week.

Each week an average of 106 Euro per patient is spend on overhead and support costs in hospital 1. For every six patients one overhead or support employee works in hospital 1.

6 Results hospital 2

This chapter presents the results of the case study in hospital 2. In the first section the hospital is generally introduced. In the second section the focus scores of the orthopaedic department and the joint care unit are determined. In the third section the remaining process alignment results are discussed. The fourth and fifth section present the production results per year and the efficiency results of the hospital.

6.1 Hospital introduction

Hospital 2 is a Dutch hospital specialized in orthopaedic healthcare. The orthopaedic department of hospital 2 does not have a joint care unit. Many patients visit hospital 2 after being referred to it by an orthopaedic medical specialist in a general or academic hospital. The hospital attracts patients from all over the Netherlands. Besides the orthopaedic department, the hospital also has specialized departments for rheumatology and revalidation. Our research concentrates on the orthopaedic department.

Staff

The total number of employees of hospital 2 is 933 FTE. Figure 42 shows the number of employees (FTE) of the relevant departments. One FTE corresponds with one person working 36 hours in one week.

Type of employee	non supporting (FTE)	supporting (FTE)
Radiologists	5,7	
X-ray department employees	32,6	
Operating room assistants	25	
Operating room supporting employees		2
Anaesthetists	6	
Anaesthetic assistants	14	
Orthopaedic inpatient nurses	49,1	
Other orthopaedic inpatient employees		17,2
Orthopaedic day care nurses	16	
Other orthopaedic day care employees		18
Supporting department's and management employees		253,8
Total	**148,4**	**291**

Figure 42: Number of employees of relevant departments of hospital 2.

The 15 orthopaedic medical specialists of hospital 2 are organized in four groups. These groups each concentrate on specific parts of the body. There are separate groups for knee, spinal, hip, and ankle, shoulder, or wrist patients. Four medical specialists are specialized in knee injuries and four in spinal injuries.

The number of medical specialist of the orthopaedic department and the knee group are presented in Figure 43. In case of the medical specialists, fellows and interns one FTE corresponds with one person working 45 hours in one week. For nurse practitioners one FTE corresponds with one person working 36 hours in one week.

Type of employee	Orthopaedic department (FTE)	Knee group (FTE)
Orthopaedics (MD)	13,6	4,0
Fellows	2,0	1,0
Interns	11,0	2,0
Nurse Practitioners	5,0	2,0

Figure 43: Number of orthopaedic medical specialists and knee group medical specialists of hospital 2. (Source: interview hospital 2.)

The proportion of time medical specialists, fellows and interns work in the outpatient clinic, operate, spend on administrative duties and spend in other ways is presented in Figure 44.

Type of employee	Outpatient clinic (%)	Operating room (%)	Administrative duties (%)	Other (%)	Total (%)
Medical specialists	40	30	15	15	100
Fellows	40	30	15	15	100
Fellows without direct supervision	40	7,5	15	15	77,5
Interns	40	40	0	20	100
Interns without direct supervision	40	0	0	20	60

Figure 44: Percentage of time medical specialists, fellows and interns of hospital 2 spend in the outpatient clinic, operating room, on administrative duties and in other ways. (Source: interview hospital 2.)

The percentage of temporary contracts for both hospital 2 and its orthopaedic department is 15%. A majority (72%) of the employees of hospital 2 works part time. At the orthopaedic department this is 59%. The part of a full-time contract, that these employees work, is added to the number of employees in FTE.

	Whole hospital	Orthopaedic department
Percentage of temporary contracts	15%	15%
Percentage of part-time contracts	72%	59%

Figure 45: Percentages of temporary and part-time contracts in hospital 2 and its orthopaedic department. (Source: hospital database.)

Resources and Partnerships

X-ray-/ MRI-department

The X-ray machines and MRI-scanner of hospital 2 are located at the same department. The X-ray-/ MRI-department is opened from 7:45-17:00 hours and on Tuesday it is opened till 19:00 hours. Patients are planned from 8:00-17:00 hours.

X-rays

The hospital has four conventional X-ray-chambers in which all types of X-rays can be made. However, to save on set-up time some of these chambers are adjusted for the making of X-rays of a specific part of the body. A patient's X-ray is made in one of the rooms based on the injured body part. There is no policy to make X-rays of the same type of injuries sequentially.

MRI-scans

When MRI-scans have to be made a different procedure is followed. The hospital has only one MRI-scanner. The waiting time for this scanner is four to five working days. Therefore

an appointment for a MRI-scan has to be made. Unlike the X-rays, the hospital plans several MRI-scans of the same body part sequentially, provided that this is possible. This is done to reduce set-up times.

Day	Opening times	Number of X-ray machines	Number of MRI-scanners	X-ray availability per week (hours)	MRI-scan availability per week (hours)
Monday – Friday (except Tuesday)	8:00 – 17:00	4	1	144	36
Tuesday	8:00 – 19:00	4	1	44	11
Total:				188	47

Figure 46: Number of X-ray and MRI-machines hospital 2 and their availability per week. (Source: interview hospital 2.)

Outpatient clinic

The working hours of the outpatient clinic are different from those of the operating room and X-ray-/ MRI-department. The outpatient clinic is opened from 8:30-17:00 hours and on Tuesdays also from 17:30-20:30 hours.

Operating room

Hospital 2 has six operating rooms divided over two locations. The first location consists of four operating rooms and five preparation beds. The second location has two operating rooms and six preparation beds. The operating room is opened from 7:30-17:00 hours and patients are planned from 8:00-16:30 hours.

Type of input	Opening times	Quantity	Availability/ week (hours)
Operating rooms	8:00 – 16:30	6	255

Figure 47: Number of operating rooms and their availability per week. (Source: interview hospital 2.)

Inpatient clinic/ day care unit

The orthopaedic department of hospital 2 has two inpatient departments and a day care unit. The inpatient departments have 37 and 41 beds, while the day care unit has 33 beds. Although patients are divided over the inpatient departments based on the part of their body that is injured, this division is not used very strictly.

Type of input	Quantity	Days	Availability/ week (days)
Inpatient beds	78	7	546
Day care beds	33	5	165

Figure 48: Number of orthopaedic inpatient and day care beds of hospital 2 and their availability per week. (Source: interview hospital 2.)

Processes

We will describe the characteristics of the three phases of the patient process as defined in section 4.1 for hospital 2. The diagnostic phase is followed by the treatment phase and the post operative phase.

Diagnostic phase

In hospital 2 patients do not need to make an appointment for the making of X-rays. X-rays can be made and analyzed on the same day as the outpatient clinic visit. In general X-rays are made after the outpatient clinic is visited. Patients receive their diagnosis on the same day, if only X-rays have to be made.

Dependant on the situation, the patient has to visit the hospital one or more times before hospitalization. The following three scenarios are possible in the diagnostic phase.

Scenario 1: one visit

During the first hospital visit the medical specialist makes the diagnosis based on the X-rays that are made that day. Subsequently the patient is screened by the medical specialist and the anaesthetist. This is done, if the medical specialist finds that the patient meets certain conditions. In this scenario the patient visits the hospital once before hospitalization.

Scenario 2: two visits

During the first hospital visit the medical specialist makes the diagnosis based on the X-rays that are made that day. The patient has to visit the hospital a second time for the preoperative screening. In this scenario the patient has to visit the hospital two times before hospitalization.

Scenario 3: three visits

During the first hospital visit the medical specialist tries to make the diagnosis based on the X-rays that are made that day. The medical specialist does not succeed and decides he needs an MRI-scan of the patient. About a week later the patient returns to the hospital for this MRI-scan and the diagnosis of the medical specialist. In the period between this last visit and the operation, the patient has to visit the hospital again for the preoperative screening. In this scenario the patient has to visit the hospital three times before hospitalization.

Scenario 2 is most common in hospital 2.

Operation and recovery phase

Based on the outcome of the diagnostic phase, the patient follows one of the forty orthopaedic clinical paths. The orthopaedic department of hospital 2 has seven clinical paths for knee patients. In these clinical paths the activities of the different employees are described. Not only the day of the operation is included, but also the days before and after. The operation itself is not part of the clinical path, however medical specialist do follow a protocol.

Most patients are hospitalized on the day of their operation. Some patients are admitted the day before their operation, if the patient's physical condition requires this.

The time a patient has to wait for an operation depends on the waiting list of the hospital for this treatment and the waiting list of the medical specialist, if the patient prefers to be operated by a specific medical specialist. Each medical specialist operates on certain days of the week. The hospital does not try to perform operations with the same surgical procedures sequentially.

Hospital 2 does not apply a joint care concept for its knee patients.

6.2 Focus results

In this section the results of the orthopaedic department and the (potential) knee group on degree of focus on patient group and the degree of focus on activities are discussed. Based on these results the place of the orthopaedic department and the potential place of the knee group of hospital 2 in Figure 3 are determined. These results are also presented in appendix C. We search for the 'potential' place of the knee group, because the knee group in hospital 2 is not a separate part of the organization. Nevertheless, it is required for the comparison with the joint care unit of hospital 1.

Degree of focus on patient group

The orthopaedic department of hospital 2 treats patients with disorders of their musculoskeletal system and connective tissue. Besides this, patients with orthopaedic injuries are treated. Therefore the patients of the orthopaedic department of hospital 2 fall in two chapters of the ICD-classification. From the blocks in these chapters about three fourth characterize the patients treated in this hospital department. The distribution of patients between these blocks is moderate.

When the patients are classified according to the ASA-classification, all patients fall in categories 1, 2 and 3. Therefore patients fall in three classes of the ASA-classification.

The focus score on patient group are presented in Figure 49.

Question	Hospital 2	Points	
ICD-classification	2 chapters	4	
Variation in patients (ICD-blocks)	about 75%	1	
Variance in ICD blocks	moderate	2	
ASA-classification	three classes	2	
	Total:	**9**	**56%**

Figure 49: Focus on patient group results, orthopaedic department of hospital 2.

The orthopaedic department of hospital 2 scores 9 of the 16 points that could be scored. This corresponds with a degree of focus score of 56%. Therefore, we consider the orthopaedic department of hospital 2 as focused on patient group.

Degree of focus on services

Since anaesthesiology and radiology are left out of consideration, orthopaedics is the only involved specialty. More than three sub-specialties are represented in the orthopaedics department of hospital 2. Examples are knee, spinal, shoulder, and hip orthopaedics.

The orthopaedic department of hospital 2 has to share the X-ray, CT and MRI-facilities with other departments of the hospital. Furthermore, these facilities are not dedicated for orthopaedic patients on (specific parts of) the day. These patients also do not get priority at the radiology department.

The orthopaedic department of hospital 2 offers surgical treatments and diagnostics. About 250 to 500 different surgical procedures and three types of diagnostics are offered in the orthopaedic department of hospital 2.

Patients with ASA-classifications 4 and 5 are not operated in the orthopaedic department of hospital 2. These patients are treated in the general or academic hospital in the same city. More than 50% of the patients have a classification equal to 3.

Operations are performed to both inpatient and day care patients. In this case, day care operations are considered as outpatient clinic operations. About 60% of the patients is treated in day care, while about 40% is admitted as inpatient.
Very few patients of this hospital need to be treated on the same day as they arrive at the hospital. An average number of five emergency patients is operated in the orthopaedic department of hospital 2 a week, while the average number of operations a week lies around 150. Therefore the percentage of emergencies is less than 5%.
These focus score on services are presented in Figure 50.

Question	Hospital 2	Points	
Number of involved specialties	orthopaedics	4	
Number of sub-specialties	> 3	0	
Radiology department	not arranged	0	
Types of services	surgical and diagnostic	2	
Variety within services	surgical 250-500; diagnostic 3 types	1	
ASA-classification	≥50% in 3; 0% in >3	3	
Inpatient / outpatient	40% / 60%	0	
Urgent cases	≤ 5%	4	
	Total:	**14**	**44%**

Figure 50: Focus on services results, orthopaedic department of hospital 2.

The orthopaedic department of hospital 2 scores 14 of the 32 points that could have been scored. This corresponds with a degree of focus score of 44%. Since this is less than 50% we consider the orthopaedic department of hospital 2 as not focused on services.

(Potential) knee group
Although hospital 2 does not have a joint care unit, such a unit might be an opportunity. Therefore, we investigate the 'potential' group of knee patients.

Degree of focus on patient group
The knee patients of hospital 2 fall into two chapters of the ICD classification. About half of the blocks in these chapters are treated by the knee group of hospital 2. The variance in patients between these blocks is perceived as high.
The knee patients of hospital 2 fall into the first three classes of the ASA-classification.

Question	Hospital 2	Points	
ICD-classification	2 chapters	4	
Variation in patients (ICD-blocks)	about 50%	2	
Variance in ICD blocks	high	1	
ASA-classification	three classes	2	
	Total:	**9**	**56%**

Figure 51: Focus on patient group results, (potential) knee group hospital 2.

The knee group of hospital 2 potentially scores 9 of the 16 points that could be scored. This corresponds with a degree of focus score of 56%. Therefore, we consider the knee group of hospital 2 as potentially focused on patient group.

Degree of focus on services

The medical specialists of the knee group of hospital 2 are orthopaedics. All these orthopaedics have the same sub-specialty: knee. No special arrangements are made for knee patients at the radiology department. The knee group of hospital 2 offers diagnostic and surgical services. Three different types of diagnostic services are used by the knee group. The number of surgical procedures lies between 50 and 100.

Most patients of the knee group fall in ASA-classes 1 and 2. A minority of the patients fall in ASA-class 3. The patients of the knee group of hospital 2 are treated inpatient as well as outpatient. The inpatient knee group patients do not have similar lengths of stay. The percentage of urgent patients is less than 5% for the knee group of hospital 2.

Question	**Hospital 2**	**Points**	
Number of involved specialties	orthopaedics	4	
Number of sub-specialties	1	4	
Radiology department	not arranged	0	
Types of services	surgical and diagnostic	2	
Variety within services	surgical 50-100; diagnostic 3 types	2	
ASA-classification	≥50% in 3; 0% in >3	3	
Inpatient / outpatient	< 75% inpatient / outpatient	0	
Urgent cases	≤ 5%	4	
	Total:	**19**	**59%**

Figure 52: Focus on services results, (potential) knee group hospital 2.

The knee group of hospital 2 potentially scores 19 of the 32 points that could have been scored. This corresponds with a degree of focus score of 59%. Since this exceeds 50% we consider the knee group of hospital 2 as potentially focused on services.

Types of focus in hospital 2

Based on the scores for focus on patient group and focus on services the orthopaedic department of hospital 2 is classified as a type II focused factory. The knee group is potentially classified as a type IV focused factory.

Figure 53 shows the location of the orthopaedic department and of the (potential) knee group of hospital 2 for focus on patient groups and focus on services plotted in the matrix of Figure 3.

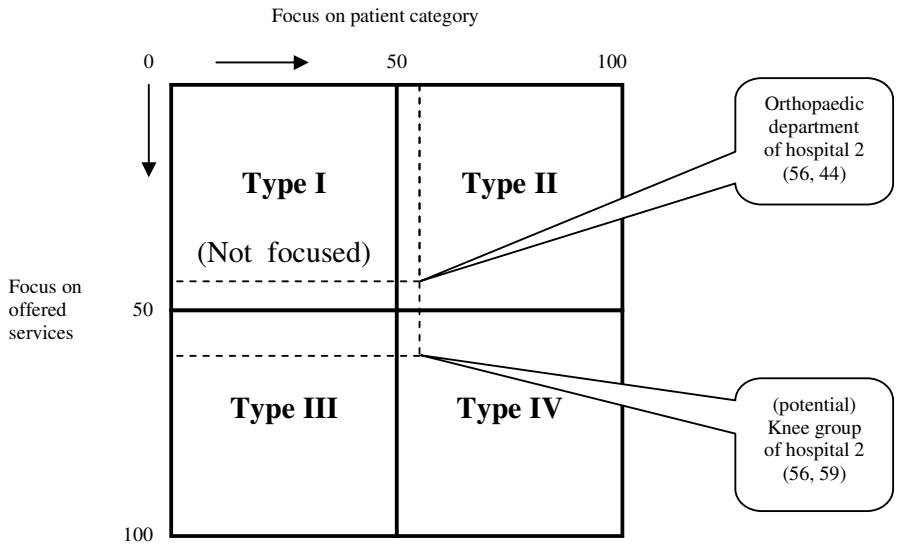

Figure 53: Place of the orthopaedic department and the potential place of the knee group of hospital 2 in focus matrix. The orthopaedic department of hospital 2 is classified as a type II focused factory. The knee group of hospital 2 is potentially classified as a type IV focused factory.

6.3 Process alignment results

This section contains information on the strategy, policy, leadership, planning, customers and people results of hospital 2. These are discussed for they give more information on the focus of hospital 2 and may influence the hospital's efficiency.

Strategy, policy and leadership

The strategy, policy and leadership of hospital 1 inform us of the importance of the focused factory for the rest of the organization.

The focus of the orthopaedic department of hospital 2 lies on the treatment of orthopaedic patients. The medical specialist are organized in four care groups. Each group treats patients with injuries to different parts of the body. The four groups are: 'knee', 'spinal', 'hip', and 'ankle, shoulder, wrist'. Each medical specialist works in the outpatient clinic and operates on fixed days. The rest of the orthopaedic department is not organized on the basis of these groups.

The management of hospital 2 supports new initiatives for a further focus developed by the medical specialists. The management itself does not develop new initiatives in this direction.

The information system of hospital 2, stores the following information: the key operational results, the financial results, the staff results and costumer results.

Planning

A good planning system can raise the production of an organization, while delays will lower it. Therefore, both influence the efficiency. In hospital 2 the planning of the orthopaedic outpatient clinic is separate of that of the operating room and the orthopaedic inpatient departments.

Orthopaedic outpatient clinic

The orthopaedic outpatient clinic planning is made by one of the employees of the orthopaedic outpatient clinic. The following variables are used:

- number of medical specialists
- number of other employees
- number of consulting rooms
- standard consultation times

In the orthopaedic outpatient clinic planning standard consultation times are used. The length of these consultation times depend on the type of visit of the patient. The following three types of visits are distinguished:

- new patient 20 minutes
- second opinion 30 minutes
- return consult 10 minutes

In the orthopaedic outpatient clinic occasional delayed consultation cause other consultations to get delayed as well. This is solved by seeing patients during the lunch break and after the normal working hours (overtime). When overtime appears to become standard procedure, the problem is discussed between management and the medical specialist. When this does not lead to less delays, the medical specialist is forced to spend more time at the outpatient clinic or operate on fewer patients.

For emergency patients, hospital 2 has a special orthopaedic first aid outpatient clinic. About 20 patients make use of this clinic each week.

Each day an average number of 1,5 appointments is cancelled in the orthopaedic outpatient clinic. This is two percent of the total number of appointments. This number does not include the patients, that do not show up, but make a new appointment. These patients are not registered as 'no show'.

Operating room

The operating room planning is made partly by the hospitals patient planning department and partly by one of the operating room employees. The patient planning department proposes a date for the operation of a patient to the operating room employee. This employee checks if all necessary materials for that operation are or can be available on that date. If all materials can be available, the date is confirmed. A month before the operation the patient is informed of the date of the operation by the patient planning department.

The final operation schedule is made by the operating room employees 48 hours in advance. Then the order of the different patients is determined. The patients conditions are taken into account.

The following variables are used when planning patients:

- the number of operation sets of the hospital
- the availability of equipment from outside the hospital
- the capacity of the central sterilisation department
- the number of employees in different categories, e.g.:
    - Anaesthetist
    - Surgeons
    - Therapists
- the patients conditions

Hospital 2 has a standard amount of time for each operation. When filling in the form for the patient planning bureau the medical specialist can decide to use this standard time. He also has the opportunity to adjust it, if he thinks he needs more time to operate the patient.
The standard time to clean an operating room and prepare it for the next patient is 20 minutes.

When an operation is delayed, employees and surgeons hope to catch up by a quicker changeover and cleaning of the operating rooms, or by an other operation that takes less time than scheduled. Each day at 14:30 hours the schedules of that day are evaluated. At this moment is decided if the rest of the schedule has to be changed. Operations can be moved to an other operating room and be performed by an other surgeon. The goal is to finish all the operations before 16:30 hours. Changes are made on a daily basis. It is also possible to move an operation to the emergency operating room. However, this operating room and its personnel are actually reserved for acute patients.
If it is not possible to move the operations, the decision is made to cancel the last operation. This patient is sent home and a new date is planned for his operation. This happens once or sometimes twice a week.

There is an emergency operating room, which has its own team. Therefore, the operation room schedule is not adapted for emergency operations.
An average of 10 operations a week is cancelled by patients. Most of these operations are rescheduled at an other date. Some patients decide they do not want to be operated in this hospital, this number of patients is unknown.

<u>Orthopaedic inpatient department</u>
The planning of the orthopaedic inpatient department is made by the patient planning department. This planning is connected to that of the operating room, since most patients are hospitalized several days after their operation.
The variables that are used in this planning, are:

- the number of beds
- the number of employees

The time patients have to stay in the inpatient clinic depends on their injury. A hospitalization time is mentioned in each clinical path.

Customers
In general, the same medical specialist that has seen the patient at the outpatient clinic operates the patient. This makes the organization less flexible in the planning of operations. In case of unforeseen circumstances, the patient can be operated by an other medical specialist, if the patient does not object.

People results
A high percentage of absenteeism of personnel due to illness makes the organization less efficient. For hospital 2 applies that absenteeism due to illness is lower in the orthopaedic department (4,5%), than in the hospital (5,2%).

	Whole hospital	**Orthopaedic department**
Percentage of absenteeism due to illness (excluding pregnancy)	5,2%	4,5%

Figure 54: Percentages of absenteeism in hospital 2 and its orthopaedic department

6.4 Production results per year

In this section the production results of hospital 2 are presented. The intention was to only present the results of the orthopaedic department and the knee patients. Unfortunately, it appeared impossible to assign all the results to these patient categories, while some departments are also used by other patients. Therefore, some of the results concern the whole hospital.
The data of the whole hospital and the orthopaedic department comes from the hospitals annual report 2005. The data of the knee treatments stems from the hospitals billing database. The aim was to use the data of the year 2005. This was not possible, since in this database the exact moment of different activities is not registered. Activities are the outpatient clinic visits, operation and hospitalization. The billing database only registers the start and end date of the treatments. Most treatments are not completed within one calendar year. This makes it hard to find the exact data for 2005. Another problem is that some of the treatments that started in 2005 were not finished in 2006, or were not added to the database at the moment the data were retrieved for this research. Therefore, we only used the data of the treatments that were completed in 2005.
We assume that this data corresponds with the number of activities that were performed in 2005, as long as the hospitals production is not growing or declining very rapidly and the same kind and severity of injuries is treated. Figure 55 shows the changes in the main results for 2004 and 2005 compared to 2003.

	2003	**2004**	**2005**
1st outpatient clinic visits	100	115	121
operations	100	113	125
knee implants	100	100	108
nursing days	100	96	101
discharges	100	108	117
average length of stay	100	89	87

Figure 55: Changes in percentages in main production results of hospital 2 compared to 2003

All activities have increased in 2005 compared to 2003. The average length of stay has dropped. Overall this means, that the presented data in the following figures are an

underestimation of reality. The production results are presented per phase of the orthopaedic process.

Diagnostic phase

In Figure 56 'Patients' stands for the number of patients that were treated in hospital 2. The '1st outpatient clinic visits' are the number of first outpatient clinic visits. 'Outpatient clinic visits' is the sum of all outpatient clinic visits. This includes the number of first outpatient clinics. The sums of all X-rays taken and MRI-scans made are presented.

Per year	Hospital	Orthopaedics	Knee
Patients	39377	24969	3815
1st outpatient clinic visits	-	20633	3117
Outpatient clinic visits	-	41839	10817
X-rays	65635	-	6204
MRI-scans	3182	-	495

Figure 56: Production results diagnostic phase, whole hospital, orthopaedic department and knee patients per year. (Source: annual report 2005 and database hospital 2.)

Operation phase

For the operation phase the number of operations is collected in Figure 57. In case of the knee patients the number of operations is subdivided in the categories ´endoscopies´, ´implants´ and ´other operations´. The numbers of 'other operations' are calculated by subtracting the number of 'endoscopies' and number of 'implants' from the 'operations'.

Per year	Hospital	Orthopaedics	Knee
Operations	-	7804	1395
Endoscopies	-	-	628
Implants	-	-	374
Other operations	-	-	*393*

Figure 57: Production results operation phase, whole hospital, orthopaedic department and knee patients per year. (Source: database hospital 2.)

Besides these different numbers of operations, also the average operating, surgical and preparation time were registered. The same applies to the proportion of operations with complete and partial anaesthesia. These data are presented in Figure 58.

Average…	Orthopaedics	Knee
Operating time (minutes)	120	130
Surgical time (minutes)	90	90
Preparation time (minutes)	30	40
Time operation room used (minutes)	90	90
Complete anaesthesia	40%	1%
Regional anaesthesia	60%	99%

Figure 58: Average operating room times and proportion of complete and regional anaesthesia. (Source: interview hospital 2.)

Post operative phase

For the post operative phase the number of ´day-care' treatments, 'nursing days' and 'discharges' is collected. These are presented in Figure 59. 'Day-care' treatments concern patients that are hospitalized, but do not spend a night in the hospital. 'Nursing days' are the number of days hospitalized patients spend in the hospital. This does not include day-care patients. The number of 'discharges' is the number times hospitalized patients were discharged from the hospital. Besides this, the 'average length of stay' is calculated by the ratio of the 'nursing days' and the number of 'discharges'.

Per year	**Hospital**	**Orthopaedics**	**Knee**
Day-care	-	5838	618
Nursing days	-	25155	5704
Discharges	-	4251	824
Average length of stay	-	*5,92*	*6,92*

Figure 59:Production results post operative phase, whole hospital, orthopaedic department and knee patients per year. (Source: database hospital 2)

Support

The overhead costs are presented in Figure 60. These consist of all costs that are not directly related to patient care and are calculated by the sum of the 'feeding costs', 'hotel costs', 'building and terrain costs' and 'other costs' as mentioned in the annual report of hospital 2. Interest and depreciation costs are not included. In 2005 the overhead costs of hospital 2 were 11.471.000 Euro. These overhead costs are not allocated to the different departments.

Per year (*1000 Euro)	**Hospital**	**Orthopaedics**
Overhead costs	11.471	-

Figure 60: Production results support phase, whole hospital and orthopaedics department per year. (Source: annual report 2005 hospital 2)

6.5 Efficiency results

In this section the input and output of hospital 2 per week are presented in the efficiency measures. With these input and output the efficiency results for hospital 2 are calculated. If necessary these results are converted in better understandable measures.

In the first column of each table "eq" stands for equipment, "pe" for personnel, and "ot" for other. This refers to the background of the efficiency measure.

Diagnosis phase

Figure 61 presents the efficiency results of the X-ray and MRI-department of hospital 2.

DIAGNOSIS		efficiency measure	Hospital	
eq	input	x-ray capacity	188	hours
	output	x-ray quantity	1262,21	X-rays
	calculation		0,15	hours/ X-ray
	score		**8,9**	**minutes/ X-ray**
eq	input	MRI-capacity	47	hours
	output	MRI-quantity	61,19	MRI-scans
	calculation		0,77	hours/ MRI-scan
	score		**46,1**	**minutes/ MRI-scan**
eq	input	x-ray quantity	1262,21	X-rays
	output	patient quantity	757,25	patients
	score		**1,67**	**X-rays/ patient**
eq	input	MRI-quantity	61,19	MRI-scans
	output	patient quantity	757,25	patients
	score		**0,08**	**MRI-scans/ patient**

Figure 61: Efficiency results diagnostic phase, whole hospital (hospital 2). The calculation is based on average input and production results per week.

These efficiency measures show that every X-ray takes approximately 9 minutes, including the time the X-ray machines are not used. For MRI-scans this is approximately 46 minutes. An average of 1,7 X-rays per patient are made, while an average of 8 MRI-scans per 100 patients are made.

In Figure 62 the efficiency results of the orthopaedic medical specialists in the outpatient clinic are presented.

DIAGNOSIS		efficiency measure	Orthopaedics	
pe	input	medical specialists	9,2	specialist outpatient time FTE
	output	outpatient clinic visits	804,60	visits
	calculation		0,01	specialist outpatient time FTE/ visit
	score		**30,9**	**minutes/ visit**

Figure 62: Efficiency results diagnostic phase, orthopaedic department (hospital 2). The calculation is based on average input and production results per week.

Medical specialist, fellows and interns spend 40% of their time in the orthopaedic outpatient clinic. This means the average time they spend per outpatient clinic visit is 31 minutes. This includes the time they need to prepare the outpatient clinic visit, add data to the patients file and wait for patients that do not show up.

Figure 63 presents the efficiency results of the knee patients of hospital 2 in the diagnostic phase.

DIAGNOSIS		efficiency measure	Knee	
ot	input	x-ray quantity	119,31	X-rays
	output	patient quantity	73,37	patients
	score		**1,63**	**X-rays/ patient**
ot	input	MRI-quantity	9,52	MRI-scans
	output	patient quantity	73,37	patients
	score		**0,13**	**MRI-scans/ patient**
pe	input	medical specialists	2,3	specialist outpatient time FTE
	output	outpatient clinic visits	208,02	visits
	calculation		0,01	specialist outpatient time FTE/ visit
	score		**29,9**	**minutes/ visit**

Figure 63: Efficiency results diagnostic phase, knee patients (hospital 2). The calculation is based on average input and production results per week.

The knee patients show differences in the number of X-rays and MRI-scans. Per knee patient an average of 1,6 X-rays are taken, while this is 13 MRI-scans per 100 knee patients. The average time medical specialists, fellows and interns spend per outpatient clinic visit of a knee patient is about 30 minutes.

Operation phase

In Figure 64 the operation room efficiency results of hospital 2 are presented.

OPERATION		efficiency measure	Hospital	
eq	input	operation capacity	255	hours
	output	operation quantity	150,08	operations
	calculation		1,70	hour/ operation
	score		**101,9**	**minutes/ operation**
pe	input	FTE OR assistants	25	FTE
	output	operation quantity	150,08	operations
	calculation		0,17	FTE/ operation
	score		**359,8**	**minutes/ operation**
pe	input	FTE anaesthetists	6	FTE
	output	operation quantity	150,08	operations
	calculation		0,04	FTE/ operation
	score		**86,4**	**minutes/ operation**
pe	input	FTE anaesthetic assistants	14	FTE
	output	operation quantity	150,08	operations
	calculation		0,09	FTE/ operation
	score		**201,5**	**minutes/ operation**

Figure 64: Efficiency results operation phase, whole hospital (hospital 2). The calculation is based on average input and production results per week.

Including the time the operating room is not used, the average time is about 100 minutes per operation. Operating room assistants spend about 360 minutes per operation. This is, because more than one assistant can participate in an operation. The same applies to the anaesthetic assistants.

Figure 65 presents the operation room efficiency results of the orthopaedic department and the knee patients.

OPERATION		**efficiency measure**	**Orthopaedics**	**Knee**	
pe	input	medical specialists	5,8	1,7	specialist operating time FTE
	output	operation quantity	150,08	26,81	operations
	calculation		0,04	0,06	specialist operating time FTE/ operation
	score		**104,3**	**171,2**	**minutes/ operation**
ot	input	average preparation time	30	40	minutes
	output	average operation time	120	130	minutes
	score	**ratio**	**0,25**	**0,31**	
ot	input	average surgical time	90	90	minutes
	output	average operation time	120	130	minutes
	score	**ratio**	**0,75**	**0,69**	
ot	input	1st outpatient clinic visits	396,79	59,94	visits
	output	operation quantity	150,08	26,81	operations
	score		**2,64**	**2,24**	**visits/ operation**
ot	input	operation quantity	150,08	26,81	operations
	output	outpatient clinic visits	804,60	208,02	visits
	score		**0,19**	**0,13**	**operations/ visit**

Figure 65: Efficiency results operation phase, orthopaedic department and knee patients (hospital 2). The calculation is based on average input and production results per week.

Medical specialists and fellows spend an average 104 minutes per operation. This is more than the average surgical time of 90 minutes. The difference is probably caused by the time they need to prepare before the different operations. Another explanation for the difference is, that it is impossible to make a perfect planning. The time that is not used between two operations or at the end of the day is included in the average time medical specialist and fellows spend per operation.

The medical specialists and fellows of the knee group need an average of 171 minutes per operation. This is more than the average surgical time of 90 minutes. It is possible that this takes more time, when more than one medical specialist or fellow are involved in one operation. Other possible explanations are the medical specialists performed more operations. The results of hospital 2 were an underestimation of the real results. Or the medical specialist spend less time in the operating room.

The second and third measures in Figure 65 show the average knee patient takes more time to prepare for an operation, than the average orthopaedic patient in hospital 2. This is probably caused by the difference in anaesthetics. From almost all knee patients only a part

of their body is anaesthetized, while an average of 60% of the average patients get their whole body anaesthetized. This last form of anaesthetics takes less preparation time.
An average of each 2,6 orthopaedic patients that visit hospital 2 for a first outpatient clinic visit, one is operated. For knee patients this is one operation for each 2,2 first outpatient clinic visits.
For every orthopaedic patient that is operated in hospital 2 the outpatient clinic is visited five times. For each knee operation this is nearly 10 outpatient clinic visits for one operation, if the patients that are not operated are included.

Post operative phase
Figure 66 presents the efficiency results of orthopaedic and knee patients of hospital 2 in the post operative phase.

POST OPERATIVE		**efficiency measure**	**Orthopaedics**	**Knee**	
eq	input	inpatient bed quantity	546	-	bed-days
	output	discharge quantity	81,75	-	discharges
	score		**6,68**	**-**	**bed-days/ discharge**
pe	input	FTE inpatient nurses	49,1	-	FTE
	output	discharge quantity	81,75	-	discharges
	calculation		0,60	-	FTE/ discharge
	score		**1297,8**	**-**	**minutes/ discharge**
eq	input	day care bed quantity	165	-	bed-days
	output	day care patient quantity	112,27	-	discharges
	score		**1,47**	**-**	**bed-days/ discharge**
pe	input	FTE day care nurses	16	-	FTE
	output	day care patient quantity	112,27	-	discharges
	calculation		0,14	-	FTE/ discharge
	score		**307,8**	**-**	**minutes/ discharge**
ot	input	length of stay	483,75	109,69	days
	output	discharge quantity	81,75	15,85	discharges
	score		**5,92**	**6,92**	**days/ discharge**
ot	input	1st outpatient clinic visits	396,79	59,94	visits
	output	outpatient clinic visits	804,60	208,02	visits
	score		**0,49**	**0,29**	**ratio**

Figure 66: Efficiency results post operative phase, orthopaedic department and knee patients (hospital 2). The calculation is based on average input and production results per week.

Including the time inpatient beds are not used, for each patient 6,7 bed-days are put into service. While the average hospitalization time per patient is 5,9 days. This corresponds with an occupation rate of 88%. The average length of stay of knee patients is 6,9 days. During hospitalization an orthopaedic patient receives an average of nearly 1300 minutes of nursing care. This corresponds with 220 minutes of nursing care a day, which is equal to 3 hours and 40 minutes.

For orthopaedic day care patients nearly 1,5 bed-days are put into service per patient. In the day care centre each patient receives an average of 308 minutes of care. This corresponds with more than 5 hours of care.
Nearly half of all orthopaedic outpatient clinic visits is a first outpatient clinic visit. This means that each patient has an average of one return consult. Nearly one third of all outpatient clinic visits by a knee patient is a first outpatient clinic visit. This corresponds with average of 2,4 return visits per first outpatient clinic visit.

Support
In Figure 67 the efficiency results of the support phase of hospital 2 are presented.

SUPPORT		**efficiency measure**	**Hospital**	
ot	input	overhead costs	220596,2	Euro
	output	patient quantity	757,25	patient
	score		**291,31**	**Euro/ patient**
ot	input	FTE support personnel	231,1	FTE
	output	patient quantity	757,25	patient
	score		**0,31**	**FTE/ patient**

Figure 67: Efficiency results support phase, whole hospital (hospital 2). The calculation is based on average input and production results per week.

Each week an average of 290 Euro per patient is spend on overhead and support costs in hospital 2. For every three patients one overhead or support employee works in hospital 2.

7 Analysis

In the first section of this chapter the focus results will be interpreted. In the second section the results of the process alignment and efficiency scores will be analysed.

7.1 Focus analysis

In chapter 5 and 6 we showed how the orthopaedic departments, the joint care unit of hospital 1 and the potential knee group of hospital 2 scored on the degree of focus on patients and services. The orthopaedic department of hospital 1 and 2 are categorized as type II focused factories, the joint care unit of hospital 1 as type IV focused factory and the knee group of hospital 2 as potential type IV focused factory. These results are also displayed in Figure 68.

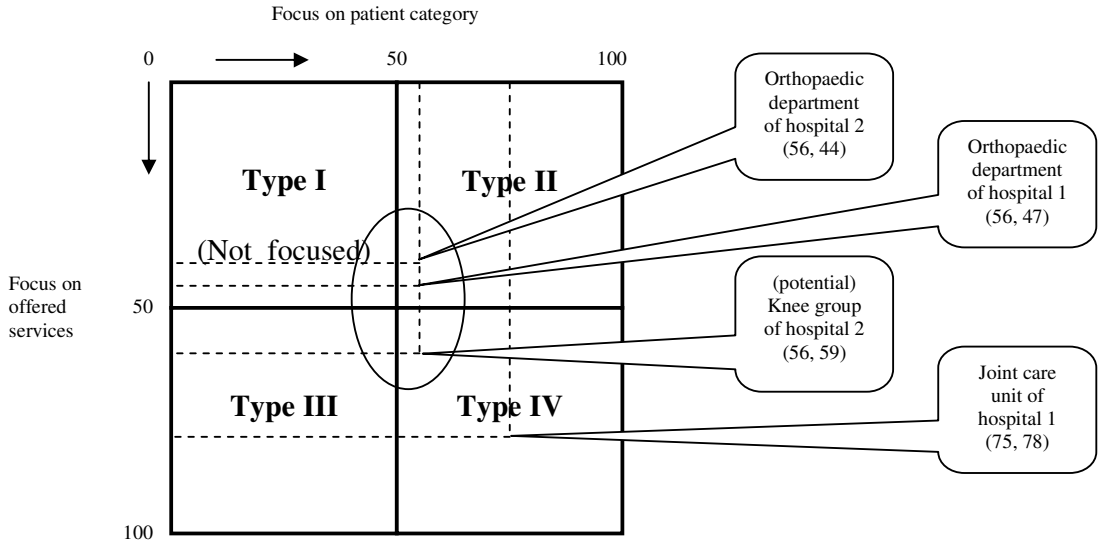

Figure 68: Place of the orthopaedic department and joint care unit of hospital 1 and of the orthopaedic department and (potential) knee group of hospital 2 in focus matrix. The oval is to mark the focused factories with minor differences in focus scores.

Although the orthopaedic departments of both hospitals have a different focus score, there are only minor differences. The orthopaedic departments received different scores for 'percentage of ICD-blocks' and 'variation within the ICD-blocks'. These differences are not visible in the scores for degree of focus on patient group.
A wider variety of surgical procedures is offered in the orthopaedic department of hospital 2. As a result of that, this department is less focused on services.

The differences in the degree of focus on patient group between the joint care unit of hospital 1 and the potential knee group of hospital 2 are caused by the 'variation in the ICD-blocks' and the 'variety between these blocks'. The potential knee group of hospital 2 has more variation in and variety between the ICD-blocks, which results in a lower score.
The difference on the degree of focus on services is caused by several things. First, the number of sub-specialties is larger in the joint care unit of hospital 1. Second, both the number of and the variety in services offered are larger in the potential knee group of hospital 2. Finally, in the joint care unit all patients are treated inpatient with a similar length of stay, while the potential knee group treats patients inpatient as well as outpatient.

Therefore, the joint care unit of hospital 1 is more focused on patients and services than the potential knee group of hospital 2.

The three focused factories near the centre of the matrix only slightly differ from each other and from both axes (50%). On the degree of focus on patient category the difference is 6% for all three focused factories. This corresponds with 1 point in this part of the questionnaire. On the degree of focus on services the differences are 3 to 9%. This corresponds with 1 to 3 points in this part of the questionnaire. Therefore, slight misinterpretations during the case studies might have led to different conclusions regarding the categories of focus of these focused factories. This should be taken into account in the interpretation of the results.

7.2 Process alignment and efficiency analysis

Strategy, policy and leadership

The focus on patient category of hospital 1 and 2 corresponds with the hospitals' strategy to concentrate the activities of their orthopaedic department on orthopaedic patients. A difference between the hospitals is, that hospital 1 has a more or less separate joint care unit for the hospitalization of some of its knee and hip patients. This unit is embedded in a department that also treats non-orthopaedic patients. Hospital 2 does not have such a separate unit, but only treats orthopaedic patients. Another difference is that hospital 2 has divided its orthopaedic medical specialist in four groups which treat specific parts of the body. The medical specialists of hospital 1 only have special interest fields.

Staff

Figure 69 displays the percentage of temporary contracts is very different for the orthopaedic departments of hospital 1 and 2.

	Orthopaedics hospital 1	**Orthopaedics hospital 2**	
Temporary contracts	1%	15%	percentage
Part-time contracts	88%	59%	percentage

Figure 69: Percentage of temporary and part-time contracts in the orthopaedic departments of hospital 1 and 2.

The orthopaedic department of hospital 1 has very few employees with temporary contracts (1%), while in the orthopaedic department of hospital 2 15% has a temporary contract. The orthopaedic department of hospital 1 has more employees with a part-time contract (88%), than the orthopaedic department of hospital 2 (59%). Assuming the time these part-time employees work is comparable for both hospitals, hospital 1 has more changeover moments and is therefore probably less efficient.

Resources and partnerships

In hospital 1 and 2 the relation with the X-ray/ MRI-department is not standardized. The X-ray machines and MRI-scanners are used by other departments of the hospital as well. Nevertheless, there are differences in the relations the orthopaedic departments have with the X-ray/ MRI-departments. For instance in hospital 1 it (officially) is necessary to make an appointment for the taking of an X-ray and the making of an MRI-scan. In hospital 2 it is only necessary to make an appointment for the making of an MRI-scan. Besides this, hospital 2 tries to plan similar MRI-scans sequentially, which is not done in hospital 1.

Figure 70 presents the operating, surgical and preparation times, just as the percentages of the types of anaesthetics used, for operations on orthopaedic and knee patients in hospital 1 and 2.

Average…	Orthopaedics hospital 1	Orthopaedics hospital 2	Knee hospital 1	Knee hospital 2	
Operation time	78	120	140	130	minutes
Surgical time	48	90	110	90	minutes
Preparation time	30	30	30	40	minutes
Time operation room used	78	90	140	90	minutes
Complete anaesthesia	25%	40%	10%	1%	percentage
Regional anaesthesia	75%	60%	90%	99%	percentage

Figure 70: Surgical and preparation times, time the operation room is used and anaesthesia percentages orthopaedic department and knee patients hospital 1 and 2.

The difference in pre-operative procedures influences the time the operation room is used. Hospital 2 has separate places at which patients are anaesthetised before an operation. This means the time an operating room is used is equal to the surgical time. In hospital 1 patients are anaesthetised in the operating room. The time the operating room is used is equal to the sum of the surgical and preparation time. To determine the operating room efficiency the times the operation room is used are compared. For orthopaedic patients this average time is shorter in hospital 1 than in hospital 2. This does not recur in the knee operations. The average time the operation room is used for knee operations in hospital 1 is longer than in hospital 2.
Comparison of the average orthopaedic surgical times shows these are much shorter in hospital 1. This is caused by the difference and lower complexity of the case-mix of hospital 1 compared to hospital 2. The difference in the types of anaesthetics used illustrates this. The average knee surgical time is shorter in hospital 2. Based on this we conclude that specialization on a specific part of the body leads to shorter surgical times, thus higher efficiency.

In Figure 71 the efficiency results of the orthopaedic operations in hospital 1 and 2 are presented.

Input	Output	Orthopaedics hospital 1	Orthopaedics hospital 2	
medical specialists	operation quantity	116,8	104,3	minutes/ operation
average preparation time	average operation time	0,38	0,25	ratio
average surgical time	average operation time	0,62	0,75	ratio

Figure 71: Efficiency results operation phase, orthopaedic departments hospital 1 and 2.

The orthopaedic medical specialists in hospital 1 spend about 12 minutes more in the operating room per operation, than their colleagues in hospital 2. This is contradictory with the average orthopaedic operating time (Figure 70). This contradiction is caused by the different sources of the information. The time of orthopaedic medical specialists per operation is based on rough estimations of how they spend their time in an average week (outpatient clinic, operation room, administrative duties and other ways). The average orthopaedic operation, surgical and preparation time is based on estimations of these times by operation room managers and are believed to be more accurate.

The ratio of the average preparation time and the average operation time is larger in the orthopaedic department of hospital 1 than in that of hospital 2. Since the average preparation time is equal, this difference is caused by the length of the operations. In hospital 2 more complicated operations are performed, therefore, this hospital has a better ratio of the average preparation and average operation time, since a smaller percentage of the operation time is used for the preparation of the patient.

Figure 72 presents two efficiency ratios for knee operations in hospital 1 and 2.

Input	**Output**	**Knee hospital 1**	**Knee hospital 2**	
average preparation time	average operation time	0,21	0,31	ratio
average surgical time	average operation time	0,79	0,69	ratio

Figure 72: Efficiency results operation phase, knee patients hospital 1 and 2.

The ratio of the average preparation time and the average operation time is larger for the potential knee group of hospital 2. This potential knee group combines a longer preparation time with a shorter surgical time, compared to the joint care unit of hospital 1 (see Figure 70). Less specialization leads to a better ratio of the average preparation and average operation time, since the preparation time is a smaller part of the total operation time. Nevertheless, the potential knee group of hospital 2 is more productive, because it has a shorter average operation time (see Figure 70). We, however, leave these results out of consideration, for the operation room procedures are not a real part of the joint care unit of hospital one.

Processes

In Figure 73 the time orthopaedics spend per outpatient clinic visit is presented, just as the ratios of the number of operations and outpatient clinic visits.

Input	**Output**	**Orthopaedics hospital 1**	**Orthopaedics hospital 2**	
medical specialists	outpatient clinic visits	21,5	30,9	minutes/ visit
1st outpatient clinic visit	operation quantity	3,21	2,64	visits/ operation
1st outpatient clinic visit	outpatient clinic visits	0,46	0,49	ratio
operation quantity	outpatient clinic visits	0,14	0,19	operations/ visit

Figure 73: Efficiency results operation phase, orthopaedic departments hospital 1 and 2.

Orthopaedic medical specialist hospital 1 spend less time per outpatient clinic visit (22 minutes), than their colleagues in hospital 2 (31 minutes). An explanation for the difference is that hospital 2 has more second opinion visits. Furthermore, hospital 2 plans more time (30 minutes) for those second opinions, than hospital 1 (20 minutes).

Hospital 1 needs more (3,2) first outpatient clinic visits to come to one operation, than hospital 2 (2,6). In both hospitals each first outpatient clinic visit is followed by an average of one return visit. For every orthopaedic patient that is operated in hospital 1 the outpatient clinic is visited an average of 7 times. This is 5 outpatient clinic visits for each orthopaedic patient that is operated in hospital 2.

An explanation for the differences in these ratios is, that many of its patients are referred to hospital 2 by an orthopaedic medical specialist in a general hospital. These patients have more sever orthopaedic injuries, that more often need an operation. However, when these ratios are considered as measures for the efficiency of the process from the outpatient clinic

to the operation room, than the orthopaedic department of hospital 2 is more efficient in diagnosing its patients.

People results

Figure 74 presents the percentages of absenteeism due to illness in both hospitals and their orthopaedic departments.

	Hospital 1	**Hospital 2**	**Orthopaedics Hospital 1**	**Orthopaedics Hospital 2**	
Absenteeism due to illness (excluding pregnancy)	5,8%	5,2%	4,9%	4,5%	percentage

Figure 74: Percentage of absenteeism in hospital 1 and 2 and their orthopaedic departments.

Absenteeism due to illness is higher in hospital 1 than in hospital 2. This also applies to the orthopaedic department of hospital 1. This explains the number of employees per patient that work in both hospitals. A higher percentage of illness makes it necessary to employ more employees. Absenteeism is also considered a measure for employee satisfaction. Since absenteeism is lower in hospital 2 and its orthopaedic department, we argue, that working with similar patients does not negatively influence employee satisfaction.

Key performance results

In Figure 75 the efficiency results of the orthopaedic patients in the inpatient departments and day care units are presented.

Input	**Output**	**Orthopaedic patients Hospital 1**	**Orthopaedic patients Hospital 2**	
length of stay	discharge quantity	5,6	5,9	days/ discharge
inpatient bed quantity	discharge quantity	7,17	6,68	beds/ discharge
bed occupation rate		78%	88%	percentage
FTE inpatient nurses	discharge quantity	1860,5	1297,8	minutes/ discharge
day care bed quantity	day care patient quantity	1,25	1,47	beds/ discharge
FTE day care nurses	day care patient quantity	264,5	307,8	minutes/ discharge

Figure 75: Efficiency results post operative phase, orthopaedic patients hospital 1 and 2.

The inpatient unit of the orthopaedic department of hospital 1 reserves an excess of 1,6 bed days per patient, while hospital 2 only reserves an excess of 0,8 bed days per patient. As a result of that, the occupation rate of the orthopaedic inpatient department of hospital 1 (78%) is worse than that of hospital 2 (88%). The orthopaedic department of hospital 1 also uses more nursing time per patient, than hospital 2. This indicates hospital 2 is more efficient in orthopaedic inpatient care. An explanation is, hospital 2 is a specialty hospital. Therefore, it has more experience in caring for orthopaedic patients in its inpatient departments. Furthermore, because hospital 2 only treats orthopaedic patients, it is better capable in planning beds and nurses.

The orthopaedic day care unit of hospital 1 is more efficient than that of hospital 2. Hospital 1 reserves less bed-days and employs less day care nurses per patient than hospital 2. An explanation for this is, that the orthopaedic day care unit of hospital 1 also treats other patients. These patients may need less care and give the hospital the opportunity to better

utilize the available capacity. Moreover, hospital 2 treats a larger amount of its patients in day care (58% compared to 44%). This means there is a possible difference in case-mix, that also explains the day care patients in hospital 2 needing more care.

Figure 76 presents the efficiency results for the support phase in hospital 1 and 2.

Input	**Output**	**Hospital 1**	**Hospital 2**	
overhead costs	patient quantity	106,33	291,31	Euro/ patient
FTE support personnel	patient quantity	0,17	0,31	FTE/ patient

Figure 76: Efficiency results support phase, hospital 1 and 2.

The overhead costs per patient are lower in hospital 1 than in hospital 2. The same applies to the number of support employees per patient. A possible explanation for this is that hospital 1 treats more patients (economies of scale).

8 Conclusions

In this chapter conclusions are drawn, based on the analysis in the previous chapter. The first section recalls the main research question and hypotheses, that are answered in this chapter. The second section presents the case study hospitals and their types of focus. The third section checks whether the hypotheses are correct. The fourth section presents the main conclusions of this research.

8.1 Research questions and hypotheses

For this research the following two research question were formulated:
"What is the relation between focus and efficiency in general and especially in orthopaedic departments?"

"How can the efficiency of the treatment of knee patients in the cooperating hospitals, using a focus factory framework, be improved?"

Since these research questions consider the relation between focus and efficiency, four hypotheses on this relation were formulated:
Hypothesis 1: focussing on a limited number of patient categories leads to a higher efficiency.
Hypothesis 2: focussing on a limited number of services leads to a higher efficiency.
Hypothesis 3: if all else stays stable, there is a maximum on the efficiency increase that a hospital can achieve through focus.
Hypothesis 4: orthopaedic departments that separate their inpatient and outpatient activities will be more efficient.

After the case study hospitals and their focus are discussed, we will present our conclusions regarding these hypotheses.

8.2 Case study hospitals and their focus

Research was done in the orthopaedic departments of two Dutch hospitals. The orthopaedic department of hospital 1 has a joint care unit. The orthopaedic department of hospital 2 has a potential knee unit. This section presents these departments, unit and their type of focus.

Orthopaedic departments
Hospital 1 is a general hospital. Orthopaedics is one of many specialties that is provided in this hospital. The orthopaedic medical specialist each have special fields of interest, but these are very wide. Hospital 2 is a specialty hospital for orthopaedics, rheumatism and rehabilitation. The orthopaedic medical specialist are organized in groups, that are specialized in specific parts of the body. The orthopaedic departments of hospital 1 and 2 have a focus on patient category and do not have a focus on services offered. Therefore, these departments are categorized as type II focused factories. The hospitals score equal on the degree of focus on patients (56%). Hospital 1 (47%) scores higher on the degree of focus on services offered, than hospital 2 (44%).

Joint care unit/ potential knee group
The joint care unit of hospital 1 is best visible in the post operative phase. The joint care unit of hospital 1 has a focus on patient category and a focus on services offered. Therefore, it is

categorised as type IV focused factory. The knee group of hospital 2 is a division in patient groups by the orthopaedic medical specialists. Within hospital 2 it is not a separate unit. However, in this research we use it as such, to be able to compare the results with the joint care unit of hospital 1. The knee group of hospital 2 has a potential focus on patient category and a potential focus on services offered. It is categorised as a potential type IV focused factory. The joint care unit of hospital 1 (75%, 78%) scores higher on focus on patient category and focus on services offered, than the potential knee group of hospital 2 (56%, 59%).

However, the potential knee group of hospital 2 is very closely located to the orthopaedic departments of hospital 1 and 2 and to the centre of the matrix. These three organizations are, therefore, not very strongly focused.

8.3 Hypotheses

In this section we check whether the formulated hypotheses are correct.

8.3.1 Effect of focusing on patient group

Hypothesis 1: focussing on a limited number of patient categories leads to a higher efficiency. Since the focus scores of the orthopaedic departments for focus on patients are similar, we in depth look into how focus score differ, to determine which focused factory is most focused.

Since, in the orthopaedic inpatient departments of hospital 1 not only orthopaedic patients are treated, the inpatient departments of hospital 2 are more focused on patients. The inpatient occupation rate is higher in hospital 2, just as the nursing time put into service per patient. Therefore, hypothesis 1 seems to be correct for the inpatient department.
In hospital 1 the orthopaedic medical specialists have (wide) special interest fields, while their colleagues in hospital 2 are specialized in a specific part of the body. Therefore, the orthopaedic medical specialists in hospital 2 seem to be more focused. Hospital 2 is more efficient in diagnosing its patients and also needs less outpatient return visits. Therefore, it seems hypothesis 1 is correct for the diagnosing of patients and for the outpatient clinic return visits.

The 'orthopaedic' day care units of hospital 1 are less focused on patients, because not only orthopaedic patients are treated. These day care units are more efficient in the treatment of orthopaedic patients, than the orthopaedic day care unit of hospital 2. Therefore, the hypothesis seems incorrect for day care.

In the support phase, we do not have data on the level of the orthopaedic department, therefore, we compare on the level of the whole hospitals. On this level we assume hospital 1 is less focused on patients than hospital 2, for hospital 1 is a general hospital. Hospital 1 has less overhead and support costs per patient and employs less support employees per patient. As a result of that, hypothesis 1 seems to be incorrect.

8.3.2 Effect of focussing on services

Hypothesis 2: focussing on a limited number of services leads to a higher efficiency. The orthopaedic departments are not focused on services. The joint care unit of hospital 1 is focused on a limited number of services. The knee group of hospital 2 is potentially focused on services.

In hospital 1 the joint care unit is for the largest part an different organization of the inpatient care. Unfortunately, we do not have comparable data on, for instance, the length of stay of these patients. Therefore, we are not able to draw conclusions on the relation between focus on services and efficiency.

8.3.3 Effect of focus on efficiency has a limit

Hypothesis 3: if all else stays stable, there is a maximum on the efficiency increase that a hospital can achieve through focus.

Unfortunately, based on this research we cannot check, if this hypothesis is correct. To be able to do that, we should have measured the efficiency increase before and after implementation of a change in focus and should have developed ways to measure if the efficiency could have increased even more.

Nevertheless, we assume that this hypothesis is correct. Focus on patients, services or both makes the service more specific. As a result of that, it is suitable for a smaller group of patients. This may make it impossible to attract a sufficient amount of patients. That would make the service less cost effective. Major changes in the process alignment or in the scale are necessary for the organization to become more efficient.

8.3.4 Effect of separating inpatient and outpatient activities

Hypothesis 4: orthopaedic departments that separate their inpatient and outpatient activities will be more efficient.

Hospital 1 has a combined orthopaedic department for day-care, inpatient care and joint care. Hospital 2 has a separate orthopaedic day-care unit. In day-care hospital 1 is more efficient, since it plans less beds and nursing time per orthopaedic patient. Hospital 2 plans less beds and nursing time per inpatient patient, this hospital is more efficient in inpatient care.
Overall, hospital 2 plans less beds and nursing time per inpatient and day care orthopaedic patient. Therefore, hypothesis 4 seems to be correct.

8.4 Main conclusion

The main research question, that was formulated, is: *What is the relation between focus and efficiency in general and especially in orthopaedic departments?*

In the previous section we have discussed the hypotheses regarding the relation between focus and efficiency. For inpatient patients, the diagnosing process and the number of outpatient clinic return visits, it seems focus on patients is more efficient. However, focus on patients seems to be less efficient in day-care and in overhead and support. We could not draw conclusions on the relation between focussing on services and efficiency, because of a lack of comparable data.
In stable situations we assume, there is a maximum on the efficiency increase that can be achieved through focus. Separating inpatient and outpatient activities seems to be more efficient.

As a result of that, we assume that in certain situations focus leads to more efficiency. In other situations the opposite is true, or the effect is not clear. The effect focus has on efficiency also depends on the process alignment of the organization. For instance, a less good planning of operations, nurses and beds reduces the effect focus has on efficiency.

Furthermore, it is important for organizations to find the right fit between focus and their environment. Focus on patients, services or both makes the service more specific. As a result of that, it is suitable for a smaller group of patients. This may make it impossible for the organization to attract an amount of patients at which the organization works cost effective. If the organization is not focused enough, it will be easier to attract a sufficient amount of patients, but per patient it will take more time and resources to treat them. That would make the service less cost effective.

The second main research question was: *"How can the efficiency of the treatment of knee patients in the cooperating hospitals, using a focus factory framework, be improved?"* This question will be answered in the following chapter.

9 Recommendations

In the first two sections of this chapter recommendations for both hospitals are discussed. Most recommendations are based on the conclusions in the previous chapter. Others are mentioned, because during the case studies the current situation appeared strange to us. Therefore, there are other improvements possible in both hospitals, that may lead to a larger efficiency increase. In the third section recommendations for further research are presented.

9.1 Recommendations to hospital 1

In this section the recommendations to hospital 1 are discussed.

Treat knee and hip patients separately

In the previous chapter was concluded that focus on patients leads to efficiency. Based on this conclusion hospital 1 is recommended to make a change in the organization of its joint care unit. At this moment knee and hip patients are treated in the same week at the same joint care unit. Hospital 1 should not mix these patient groups. It would be better to treat knee patients in one week and hip patients in the other.

Perform joint care operations sequentially

Furthermore, because focus on patients leads to more efficiency, hospital 1 is advised to do research on performing joint care operations sequentially. These operations should be performed by the same team of a medical specialist, operating room assistants and anaesthetic assistant. In this team, the operating room assistants should stick to one role. Research is required, since these changes also effect the focus on services. It should point out whether further standardization of operation room procedures are possible and lead to a reduction of operating time.

Further specialization by the medical specialists

More focus on patients can also be reached by further specialization of the orthopaedic medical specialists. They can consider adapting their special fields of interest. However, they have to make sure, that the patient base remains large enough.

No mixed nursing departments

Since focus leads to more efficiency, hospital 1 should consider to stop mixing orthopaedic and non-orthopaedic patients in the nursing departments. This also applies to the mixed day care unit and inpatient department. Only patients with similar injuries or diseases should be treated in the same department at the same time.

Furthermore, hospital 1 seems to have overcapacity in its orthopaedic inpatient departments. The hospital should consider reducing the capacity in inpatient beds and nursing time. This would lead to higher occupation rates.

MRI planning

We noted that hospital 1 has a shortage in its MRI-capacity. The hospital is recommended to do research in changing the planning of the MRI-scans. This should point out, if planning similar MRI-scans sequentially leads to more efficiency, because of the (temporary) focus on

patients and reduction in changeover times. If this reduction is at least 5 minutes per MRI-scan, it is possible to increase MRI- production by 10%.

One location for pre-operative screening
The last recommendation to hospital 1 does not directly make its process more efficient, but it will make it more patient friendly. During the case study visit, we noted that the orthopaedic consultants and the anaesthetists consult patients at different locations. Patients, therefore, have to visit the hospital an extra time. When they consult the patients at the same location as the orthopaedic medical specialists and joint care unit is situated, patients will have to visit the hospital fewer times.

9.2 Recommendations to hospital 2

This section presents the recommendations to hospital 2.

Start a joint care unit
Since focussing on patients leads to more efficiency, the main recommendation to hospital 2 is to start a joint care unit for its knee patients. Although at this moment hospital 2 is more efficient in the inpatient care of its knee patients, than hospital 1, hospital 2 can use a joint care unit to remain 'in the lead'.

Each year an average of 370 knee patients have an operation with an implant. Of these patients about 180 have a length of stay of 6 to 8 days. Efficiency can be raised if the length of stay of these patients can be reduced. Knee patients with an expected length of stay of 4 to 5 days can be treated in the unit to raise the number of patients. If this does not lead to enough patients for a cost effective exploitation of the joint care unit, hospital 2 can consider to treat hip patients in this unit as well. In that case the two patient groups should not be mixed, but be divided over separate weeks.
Besides the reduction in length of stay, improvements can be reached in the operation room. By operating the knee patients of the joint care unit sequentially, further standardization of operation room procedures seems possible. This can lead to a reduction of the operation time.

Divide inpatient patients more strictly
In the previous chapter was concluded that focus on patients leads to more efficiency. Therefore, an other recommendation to hospital 2 is to more strictly divide the patients over the orthopaedic inpatient departments. More specialization in the inpatient department would be more efficient. However, the hospital needs to keep in mind, that the patient base of each group has to keep a sufficient size.

9.3 Recommendations for further research

In this section the focus questionnaire and the efficiency score instrument are evaluated. After that, recommendations for further research are presented.

Focus questionnaire
The focus questionnaire gives an impression of the degree focus on patient group and services of an organization. However, some critical remarks are to be made.

Three of the focused factories in this research obtained the same score for degree of focus on patient group. This is partly caused by the fact that this part of the questionnaire consists of only four questions. More questions are required to make more diversity possible.
Another option would be to replace the question on the ASA-class of the patients (question 4), by one or more other questions that measure the patients' health. A disadvantage of the ASA-classification is that it differentiates in only five classes for a patients' health. Another disadvantage is, that patients in the classes 4 and 5 will never visit a hospital with orthopaedic complaints. This limits the differentiation in score between the focused factories.

The question on the variety in the services offered (question 9) can be adjusted in the part of the questionnaire for degree of focus on services. In case of multiple services, the largest variety, leading to the lowest score, needs to be chosen. When there is great difference in score between the services, this does not recur in the focus score. It would be better to apply the focus questionnaire not on the whole (patient) process, but on separate phases of it. This makes it possible to split the multiple services of question 9. Furthermore, the degree of focus on patient group and focus on services can be different in the outpatient clinic, operation room and inpatient clinic. A focus score for the whole process makes these differences unclear.

A final adjustment that can be made is to the focus score matrix (Figure 3). Van Lent, et al (2005) decided, that the four categories have solid boarders. Replacing these boarders by gray areas between for instance the 40% and 60% lines, would make clear that some focused factories are discussable.

Process alignment
A disadvantages of the process alignment questionnaire is that some questions are similar to the efficiency measures or ask for comparable data. This, for instance, applies to the key performance results.
Furthermore, some questions appeared less relevant in this research, for instance the questions on leadership, strategy, policy and customers.

Efficiency measures
In the core, the efficiency measures seem to be suited for completely independent focused factories. However, it is difficult to use the measures when the focused factory shares resources and data has to be allocated. In this research for instance the allocation of X-ray and MRI-capacity was impossible.

A disadvantage of some measures (e.g. inpatient and day care), is that these do not use data on the official capacity that is necessary to treat a patient, but use data on the capacity that is put into service. It would be better if a distinction was made between focused factories that are inefficient and focused factories that have overcapacity. This would show the difference between working inefficient and planning inefficient.

Furthermore, the division of medical specialists time over an average week is not useful for accurate calculation of the operation time of a patient or of an outpatient clinic visit. It would be better to take a random check of two or three weeks on how they spend their time.

Further research

To find more information on the relation between focus and efficiency in hospitals, it is necessary to do further research. For instance a comparison between hospitals with comparable case-mix; like two orthopaedic hospitals. In this project this, unfortunately was impossible. Comparable case-mixes will give more insight in the relation between focussing on services and efficiency.

10 Reflection

In this chapter I will reflect on the research. I will start with a reflection on the literature study, after that one on the case study and finally one on the writing of the report.

Literature study

I experienced the literature study as an enjoyable part of the research. Probably this was partly, because it was the beginning of the research. I had not expected to find as many articles and books on focus and on efficiency. However, it was disappointing to find out how few of these were relevant for my research. Fortunately, in most cases the summary gave enough information to make a good judgement.

Case study

During the case studies I experienced several ups and downs. I thought it very interesting to visit the hospitals and walk in the inpatient departments, outpatient clinics and operation room, seeing the process with my own eyes and discovering that there are differences between the way the interviewed managers see the process and the way the employees perform it.

Disappointing was the time the case studies took and the changes that had to be made to come to a completion of the project. At various moments I found it hard to stay motivated. Even that was educational after all. For instance, in a following project I will insist on having the crucial appointments made before the start of the project.
Besides that, I also experienced how important it is to have good contact with and support of the manager of the involved department. This opens doors to other managers and relevant data, that else would have taken much more time to open, or would have remained closed.

Furthermore, I also found out, that I prefer working and puzzling with a rough data sets over a screened versions with only the total numbers. In a following project working with the first type of data set will have my preference.

Writing the report

I found it more difficult to write in English, than I had imagined before the start of the research. Not only to find the right words in English, but also to write short, active sentences. Although it would probably have taken less time, if the report had been written in Dutch, I think it has been a useful experience to write a report of this length in English. Furthermore, the lesson to write as much active sentences as possible will be applied in Dutch as well.

To my opinion, drawing the conclusions was the hardest part of the whole research. Most importantly, because these could not be drawn along a straight line. At this moment I am still not sure whether the conclusions are correct and complete. That is one of the things I will have to work on in a future research project.

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Appendix A: Case study protocol

This appendix contains the case study protocol for this research. Data will be collected on the macro level of the hospital and on the meso level. This is done to make a comparison possible between complete hospitals and hospital departments.

Part one: General information of hospitals

The hospitals will be compared to find out if the differences between the hospitals are not too large to stand in the way of an honest comparison of the focused factories. The following indicators will be measured for the year 2005:

- Location of the hospital
- Type of organization
- Type of organizational structure
- Position of focused factory within the hospital
- Number of possible patients living in the vicinity of the hospital
- Number of employees (FTE)
- Number physicians (FTE)
- Number of first outpatient clinic visits
- Number of operating rooms
- Number of operations performed
- Number of day care treatments
- Number of beds
- Number of inpatient days

The following sources will be used to retrieve this information:
- Annual report 2005
- Hospital website

If necessary the manager of the orthopaedic department will be interviewed on this subject.

Part two: Focused factory information

Different categories of information of the focused factories will be compared. First it is necessary to find out the degree of focus. Therefore, the measure of Van Lent (2005) will be used. Furthermore, the process alignment will be measured with an adapted version of the questionnaire by Van Lent (2005). Moreover, the efficiency of the focused factories will be measured.

Degree of focus measures

This part measures the degree of focus in the hospital(department). Two dimensions determine focus in a hospital. Definitions for both dimensions explain differences:

- Degree of focus on offered services:
  the degree to which (a part of) the hospital performs a limited range of tasks.
- Degree of focus on patient group:
  the degree to which (a part of) the hospital serves a limited, selected, well-defined and comparable group of patients, whose diagnoses share the same characteristics.

These two dimensions of focus in a hospital have led to a classification model (Figure 3). An organization can only be a focused factory if it is a type II, III or IV focused organization. This questionnaire is used to determine the type of focused organization.

Measuring the degree of focus on patients (patient group)

These questions gather information about: the groups of patients that are treated, the volume of these groups, and the variety (between and within these groups). These questions give us information about the customer needs and particularities.

Question 1

We would like to know how many patient groups are treated in your organization. A patient group will be considered as all patients that belong to one chapter of the ICD classification (please see Figure 77).

Chapter	Blocks	Title
I	**A00-B99**	Certain infectious and parasitic diseases
II	**C00-D48**	Neoplasms
III	**D50-D89**	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism
IV	**E00-E90**	Endocrine, nutritional and metabolic diseases
V	**F00-F99**	Mental and behavioural disorders
VI	**G00-G99**	Diseases of the nervous system
VII	**H00-H59**	Diseases of the eye and adnexa
VIII	**H60-H95**	Diseases of the ear and mastoid process
IX	**I00-I99**	Diseases of the circulatory system
X	**J00-J99**	Diseases of the respiratory system
XI	**K00-K93**	Diseases of the digestive system
XII	**L00-L99**	Diseases of the skin and subcutaneous tissue
XIII	**M00-M99**	Diseases of the musculoskeletal system and connective tissue
XIV	**N00-N99**	Diseases of the genitourinary system
XV	**O00-O99**	Pregnancy, childbirth and the puerperium
XVI	**P00-P96**	Certain conditions originating in the perinatal period
XVII	**Q00-Q99**	Congenital malformations, deformations and chromosomal abnormalities
XVIII	**R00-R99**	Symptoms, signs and abnormal clinical and laboratory findings, not elsewhere classified
XIX	**S00-T98**	Injury, poisoning and certain other consequences of external causes
XX	**V01-Y98**	External causes of morbidity and mortality
XXI	**Z00-Z99**	Factors influencing health status and contact with health services
XXII	**U00-U99**	Codes for special purposes

Figure 77: Main topics ICD classification, needed to answer question I, II and III

How many of the ICD classification chapters describe your patients? Please consider the period of a year (preferably 2005). Only one answer possible.

a. one or two chapters (4)
b. three chapters (2)
c. more than three chapters (0)

Question 2
We are interested in the variation in patients (defined by ICD code) treated. Each chapter of the ICD classification consists of a number of blocks. What percentage of blocks in the chapters indicated in question 1, describes your patients? Please consider the period of a year (preferably 2005). If multiple chapters were indicated in question 1, describe the overall percentage. Only one answer possible.

a. 0-20% (4)
b. 20-40% (3)
c. 40-60% (2)
d. 60-80% (1)
e. >80% (0)

Question 3
We are interested in how patients are distributed between the blocks. Large differences between blocks suggest high variety in patient needs. Please indicate how you value the variety in the number of patients between blocks of a chapter.

Please indicate how the variety in numbers of patients between blocks is perceived
a. very high (0)
b. high (1)
c. moderate (2)
d. low (3)
e. very low (4)

Question 4
The health of a patient can be described by the Classification of the American Society of Anesthesiologists (ASA). Each ASA class (Please see Figure 78) describes a different physiological situation of a patient. Patients classified as ASA 1 have fundamentally different needs than patients classified as ASA 4. Limiting an organization to serve patients classified to only one or a few ASA classes suggests a higher degree of focus on patient groups.

Class	Description
I	The patient is normal and healthy
II	The patient has mild systemic disease that does not limit their activities (e.g., controlled hypertension or controlled diabetes without systemic sequellae)
III	The patient has moderate or severe systemic disease, which does limit their activities (e.g., stable angina or diabetes with systemic sequellae).
IV	The patient has severe systemic disease that is a constant potential threat to life (e.g., severe congestive heart failure, end-stage renal failure).
V	The patient is morbid and is at substantial risk of death within 24 hours, with or without surgery.

Figure 78: ASA classification, needed to answer question 4

How many ASA classes describe the patients receiving the care of your organization?
a. one or two ASA classes (4)
b. three ASA classes (2)
c. more than three ASA classes (0)

Total score focus on patients: 16. Calculate percentage (0-100 score).

Focus on services offered (processes)

These questions gather information about the number of involved specialties, the number of offered services, the variety in services and some patient characteristics that strongly influence the predictability of care delivery system.

Question 5

We are interested in the number of specialties that are involved in the delivery of care in your organization. Radiology and Anaesthesiology must be excluded in this number.

How many specialties are involved in your organization?

a. one specialty (4)
b. two specialties (2)
c. more than 3 specialties (0)

Question 6

We are interested in the number of subspecialties within the specialties in your organization. Please indicate which option applies.

How many subspecialties are involved in your organization?

a. one subspecialty (4)
b. two subspecialties (2)
c. more than 3 subspecialties (0)

Question 7

Does your organization has its own (dedicated) radiology department? Please, indicate if your organization does not use X-ray, CT or MRI imaging in serving its patient groups.

a. Yes, we have our own radiology department (4)
b. No, but the radiology department is ours for the majority (90%) of the day (3)
c. No, but (part of) the radiology department is ours on specific (parts of) days (2)
d. No, but we have a higher priority at the radiology department (1)
e. No, the radiology department is a shared resource out of our control (0)
f. No, we don't use X-ray, CT or MRI in serving patients (not applicable)(4)

Question 8

The number of services your organization offers is measured by the number of treatments or diagnostics offered. We identify medical, surgical, and radiation treatments. We therefore distinguish between four types of services: 1) medical treatments, 2) surgical treatments, 3) radiation treatments, and 3) diagnostics.

Please indicate how many of these types of services your organization offers

a. Only one of these types of services (4)
b. Two of these types of services (2)
c. More than two types of services (0)

Question 9

For each type of service offered, we are interested in the variety within this service. In the case of medical treatments, we are interested in the number of medicines used, and the number methods for administering these medicines. In the case of surgical treatments we are interested in the number of different surgical procedures performed. In the case of radiation treatments we are interested in the variety within treatment times. In the case of diagnostics we are interested in the number of diagnostic services (techniques/ technologies) used such as lab-tests, radiology, physical exam, ECG, etc.

Please indicate, for each service your organization offers, which options applies.

medical

a. few medicines, few methods (4)
b. multiple medicines, few methods (3)
c. moderate medicines and methods (2)
d. Few medicines multiple methods (1)
e. Multiple medicines and methods (0)

surgical

a. < 50 different procedures (4)
b. 50-100 different procedures (3)
c. 100-250 different procedures (2)
d. 250-500 different procedures (1)
e. > 500 different procedures (0)

radiation

a. very high variety in treatment times (0)
b. high variety in treatment times (1)
c. moderate variety in treatment time (2)
d. low variety in treatment times (3)
e. very low variety in treatment times (4)

diagnostics

a. one or two diagnostics used (4)
b. three diagnostics used (2)
c. four or more diagnostics used (0)

If multiple services were indicated, use the lowest score when establishing the degree of focus on offered services.

Question 10
These ASA classes (see Figure 78), used to describe the health of patients, can also seriously influence the predictability of the delivery of care. Although the ASA classification depends on patients, we also see it as an indicator for interruptions in the delivery of care. Patients in the high ASA classes require a care delivery system that is able to rapidly respond to unpredictable events. Patients in the low ASA classes mainly require routine care. The ASA classes that occur in the care delivery system therefore indicate the predictability of this system.

Please, indicate which option applies for your organization.

a. no patient has an ASA classification higher than 2 (4)
b. Less than 50% of the patients have an ASA classification equal to 3, no patients have an ASA classification higher than 3 (3)
c. more than 50% of the patients have an ASA classification larger or equal to 3, but no patients have an ASA classification equal or higher than 4 (2)
d. more than 25% of the patients have an ASA classification higher or equal to 4 (1)
e. more than 50 % of the patients have an ASA classification higher or equal to 4 (0)

Question 11
Another process characteristic is the percentage of inpatient and outpatient admissions compared to the total number of admissions. The percentage of inpatient and outpatient admissions and the variety in the length of stay (LOS) for inpatient hospital stays are other process characteristics that are of importance. Short stay is defined as a LOS < 30 days. Long stay as a LOS > 30 days.

Please indicate which option applies for your organization.

a. more than 95% of all patients are treated inpatient or outpatient, with similar LOS (4)
b. more than 75% of all patients are treated outpatient, and inpatient LOS is < 5 (2)
c. less than 75% of all patients are treated either outpatient or inpatient (0)

Question 12
Also the number of urgent cases tells us something about the services offered, and their predictability. It is possible to focus on non-urgent cases, as it is to focus on urgent cases.

Please indicate which option applies for your organization.

a. more than 95% or less than 5 % of all patients are urgent cases (4)
b. other (0)

Total score focus on services: 32. Calculate percentage (0-100 score).

Calculate the degree of focus and classify the type of focus factory

Focus on patient group
Sum the scores of the questions 1 to 4. Divide this score by the maximum possible score of 16 points. Multiply the result with 25. Round the result which gives a focus score of 0 – 25.

Focus on services offered
Sum the scores of the questions 5 to 11. Divide this score by the maximum possible score of 28 points. Multiply the result with 25. Round the result which gives us a focus score of 0 – 25.

The choice for 25 is made, since this lies between 16 and 28, the maximum scores of the focus on patient group and the focus on services offered.

Classifying the type of focused factory
Use the calculated scores to plot this case on the dimensions 'patient group' and 'services offered' in the figure.

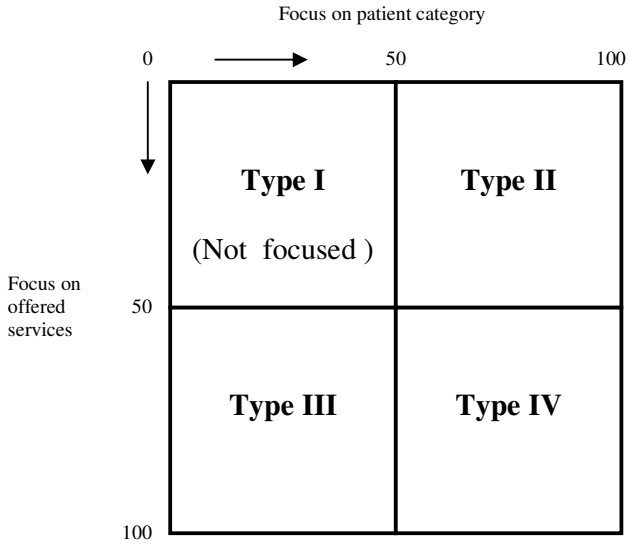

Figure 79: Types of focused factories with scores (0 – 25) in figure

Focus Type	Patient Group Score	Services Offered Score
I	0 – 50	0 – 50
II	50 – 100	0 – 50
III	0 – 50	50 – 100
IV	50 – 100	50 – 100

Figure 80: Types of focused factories with scores (0 – 100) in table

The information for this measure will be retrieved through the following sources:
Interviews with:

- The manager of the orthopaedic department

Perhaps the annual report 2005 and the management information system can also be useful.

Part three: Process alignment measures

<u>Enablers</u>

Leadership

1. Do leaders stimulate initiatives for focused factories?

Strategy and policy

2. The policy contains an obvious choice for the focused factory: a choice has been made to limit the range of activities and/ or the range of served patients.
3. The existing information system (not necessarily IT) delivers information about:
    a. The key operational results. For example the number of patients treated, occupancy rates, etc.
    b. Financial results of the department.
    c. The staff results for this specific process. The amount of staff in FTE, what functions, hours worked, staff costs, staff turnover, and absence due to illness.
    d. Customer results. For example the waiting time for patients, satisfaction.

Staff

4. What is the number of staff in FTE?
    a. In the focused factory
    b. In the non focused units
5. What is the rate of temporary contracts?
    a. In the focused factory
    b. In the non focused units
6. What is the rate of part-time contracts?
    a. In the focused factory
    b. In the non focused units

Resources & Partnerships

<u>Materials and services</u>

7. How many treatments can be performed in the focused factory?
    a. diagnosis capacity per week
    b. day surgery patient capacity per week
    c. operating rooms patient capacity per week
8. Which categories of treatments are distinguished in the focused factories?
9. What percentage of patients falls in which category?

<u>Knowledge and technology</u>

10. Is there a protocol which describes the whole treatment?

Partnerships:

11. Relation with X-ray-department:
    a. What are the opening hours of the X-ray-department?
    b. Where is the X-ray-department situated compared to the outpatient clinic?
    c. What is the waiting time for the taking of an X-ray?
    d. Do patients for the focused factory receive a preference treatment above others?
    e. How much time is needed to analyze the X-rays of a patient?
    f. Is it necessary to make an appointment for the X-ray analysis?
    g. Are X-rays made before the first outpatient clinic visit?
    h. Are X-rays made on the same day as the treatment?
12. Relation with MRI-department:
    a. What are the opening hours of the MRI-department?
    b. Where is the MRI-department situated compared to the outpatient clinic?
    c. What is the waiting time for the taking of an MRI?
    d. Do patients for the focused factory receive a preference treatment above others?
    e. How much time is needed to analyze the MRI-scan of a patient?
    f. Is it necessary to make an appointment for the MRI-analysis?
    g. Are MRI-scans made before the first outpatient clinic visit?
    h. Are MRI-scans made on the same day as the treatment?
13. Relation with the operating room:
    a. What are the opening hours of the operating room?
    b. Where is the operating room situated compared to the nursing department?
    c. Is the operating room only available for the focused factory? If other departments also use it, give an estimation of the distribution of the workload between the departments.
    d. When is the operating room planning made?
    e. What is the estimated operating time?
    f. Are operations of focused factory patients scheduled after each other?

Processes

14. What are the working hours of the focused factory?
    a. Do different parts of the focused factory have different working hours?
        i. Outpatient clinic?
        ii. Inpatient department?
        iii. Operating room?
    b. Do these working hours differ from the non focused units of the hospital?

15. Description of the planning system:
    a. Who is responsible for the planning?
    b. Are different departments or employees responsible for the planning of the
        i. Outpatient clinic?
        ii. Inpatient department?
        iii. Operating room?
    c. What variables are used for the planning? E.g. available beds, staff, workload?
    d. How is the treatment time determined?
    e. Is a differentiation made in the process between patients? Are patients distinguished per type of injury/ treatment?
    f. During what times are patients scheduled?
    g. How long is the planning horizon?
    h. What is done if a treatment is delayed? What impact does this have on other treatments?
16. What is the average number of times the focused process is disturbed (by e.g. an emergency treatment)?
    a. What is done with emergency treatments?
17. What is the average number of cancelled appointments?
    a. In the outpatient clinic?
    b. In the inpatient department?
    c. In the operating room?
18. Estimated times of activities:
    a. Estimated average surgery time?
    b. Estimated time needed to prepare the operating room for the next patient?
    c. Estimated average length of stay before surgery?
    d. Estimated average length of stay after surgery?

Results

Customer

19. Is the focused factory a 'one stop shop'? If not:
    a. Are all diagnostic activities performed on one day? Is the patient informed of the result on that same day?
    b. Are patients operated on the same day they receive the diagnosis?
    c. How many times does a patient visit the hospital before operation?
20. Does the organization try to achieve that each patient sees the same specialist every visit?
21. Information about the treatment:
    a. Does the hospital have an information centre?
    b. Who informs the patient about the treatment?
    c. Is the patient informed about the time needed for the treatment?
    d. Who is available for questions?

People results

22. Satisfaction of staff:
    a. What is the rate of absence due to illness?
        i. For the whole hospital? How is this compared to other hospitals?
        ii. For the focused factory? How is this compared to the non-focused parts of the hospital?

Key Performance results

23. Total number of patients treated in 2005
    a. Percentage of focused factory patients
    b. Percentage of non focused patients
    c. Percentage of day surgery patients
        i. Percentage focused
        ii. Percentage non focused
    d. Percentage of inpatient patients
        i. Percentage focused
        ii. Percentage non focused
24. Length of stay, for the complete hospital and focused units:
    a. Percentage of length of stay of 1 night?
    b. Percentage of length of stay of 2 nights?
    c. Percentage of length of stay of 3 nights?
    d. Percentage of length of stay of 4 nights?
    e. Percentage of length of stay of 5 nights?
    f. Percentage of length of stay of 6 or more nights?
25. What is the average time for activities, for the complete hospital and focused units?
    a. Average surgery time?
    b. Time needed to prepare the operating room for the next patient?
    c. Average length of stay before surgery?
    d. Average length of stay after surgery?
    e. What is the average waiting time between treatment decision and operation?

The information on the process alignment of the focused factories will be retrieved through the following sources:

- Hospital website
- Annual report 2005
- Management information system
- Interviews:
    The manager of the orthopaedic department
    The manager of the spinal outpatient clinic
    The manager of the knee outpatient clinic
    The manager of the OR-department
    The manager of the nursing department

A distinction is made for which information will be retrieved through which sources. This can be found in the last part of this case study protocol.

Part four: Efficiency measures

The following measures will be used to measure the efficiency of hospitals and the focused factories. Therefore, all data needs to be collected of the hospitals as well as of the focused factories. The efficiency measures are categorized based on the processes in a hospital. The diagnostic phase, operation phase, post operative phase and support are distinguished. For some categories alternative measures are mentioned.

Diagnostic phase

The capacity of equipment is calculated by multiplying the number of equipment reserved for the focused factory with the time the equipment is reserved for the focused factory. The average capacity that is available in one week is calculated. As input measure for the personnel the number of employees in FTE is used. If a piece of equipment is not only used by the focused factory, the number of employees is determined by the sum of time in hours the employees work for focused factory patients in a week and divided by 40 hours. The same is done for the medical specialists and the time they spend on diagnosing patients.

Diagnostic phase		
Equipment		
inputs	**outputs**	**source**
total X-ray capacity	quantity of X-rays made	(i) adapted from Schuring et al (2004)
total MRI-capacity	quantity of MRIs produced	(o) adapted from Schuring et al (2004)
Personnel		
inputs	**outputs**	**source**
FTE radiology employees	quantity of X-rays made	(i) (o) adapted from Schuring et al (2004)
FTE MRI employees	quantity of MRIs produced	(i) (o) adapted from Schuring et al (2004)
FTE medical specialists (MDs)	number of outpatient clinic visits	(o) Chilingerian et al (2004)
FTE medical specialists (interns)	number of outpatient clinic visits	(o) Chilingerian et al (2004)

Figure 81: Diagnosis – equipment and personnel inputs and outputs with sources

If the hospital does not make a distinction between radiology and MRI personnel, this alternative measure will be used.

Diagnostic phase – Alternative measures 1		
Equipment		
inputs	**outputs**	**source**
total X-ray capacity	quantity of X-rays made	(i) adapted from Schuring et al (2004)
total MRI-capacity	quantity of MRIs produced	(o) adapted from Schuring et al (2004)
Personnel		
inputs	**outputs**	**source**
FTE radiology + MRI employees	quantity of X-rays and MRIs made	(i) (o) adapted from Schuring et al (2004)
FTE medical specialists (MDs)	number of outpatient clinic visits	(o) Chilingerian et al (2004)
FTE medical specialists (interns)	number of outpatient clinic visits	(o) Chilingerian et al (2004)

Figure 82: Diagnosis: Alternative measure 1

The measures will also be replaced, if it is not possible to measure the capacity use of these equipments or employees. This is for example possible, if the hospital has not reserved the use of the equipment on certain (part of) days for the focused factory. Then the following measures will be used.

Diagnostic phase – Alternative measures 2		
quantity of X-rays made	quantity of patients diagnosed	
quantity of MRIs produced	quantity of patients diagnosed	
Personnel		
FTE medical specialists (MDs)	number of outpatient clinic visits	(o) Chilingerian et al (2004)
FTE medical specialists (interns)	number of outpatient clinic visits	(o) Chilingerian et al (2004)

Figure 83: Diagnosis - Alternative measure 2

Operation phase

The next measures are developed to measure the efficiency of the operation phase.

Operation phase		
Equipment		
inputs	**outputs**	**source**
total operating room capacity	number of inpatient surgeries	(i) Chilingerian et al (2004), (o) adapted from Schuring et al (2004), (o) adapted from Veillard et al (2005)
Personnel		
inputs	**outputs**	**source**
FTE operating room personnel	number of inpatient surgeries	(i) Schuring et al (2004), (o) adapted from Schuring et al (2004), (o) adapted from Veillard et al (2005)
surgical time	total operating room time	
preparation time	total operating room time	

Figure 84: Operation phase – equipment and personnel inputs and outputs with sources

For the operation phase also applies that the measures will be replaced if the focused factory capacity use of personnel and equipment can not be measured. This for example, because of a lack of distinction between operations performed on focused factory patients and on other patients.

If it is not possible to assign personnel to the focused factory patients, the number of employees will be calculated. Therefore, the percentage of operations on focused factory patients in relation to the total number of operations will be multiplied with the number of employees in FTE. This leads to the FTE* in Figure 85.

Operation phase – Alternative measures		
Equipment		
inputs	**outputs**	**source**
time spent on inpatient surgeries	number of inpatient surgeries	(i) Chilingerian et al, 2004, (o) adapted from Schuring et al (2004), (o) adapted from Veillard et al (2005)
Personnel		
inputs	**outputs**	**source**
FTE operating room personnel*	number of inpatient surgeries	(i) Schuring et al (2004) (o) adapted from Schuring et al (2004), (o) adapted from Veillard et al (2005)
surgical time	total operating room time	
preparation time	total operating room time	
number of outpatient clinic visits	number of operations	

Figure 85: Operation phase – Alternative measures

Post operative phase

The next measures are used to determine the efficiency in the post operative phase. If it is not possible to assign medical specialists or nurses to the focused factory patients, their number will be calculated. For medical specialists this is done by the sum of time in hours they consult patients in a week and divided it by 40 hours. The number of nurses is calculated as the ratio of the length of stay of focused factory patients and non focused factory patients. The product of this ratio and the number of nurses of the department in FTE determines the input measure.

Post operative phase		
Equipment		
inputs	**outputs**	**source**
number of beds	average number of discharges a week	(o) Chilingerian et al (2004)
Personnel		
inputs	**outputs**	**source**
FTE nurses	average number of discharges a week	Chilingerian et al (2004)

Figure 86: Post operative phase – equipment and personnel inputs and outputs with source

If it is not possible to assign beds to the focused factory patients either, the following alternative measures will be used.

Post operative phase – Alternative measures		
average length of stay in weeks	average quantity of discharges a week	
number of first outpatient clinic visits	number of outpatient clinic visits	

Figure 87: Post operative phase – Alternative measure

Support

With the 'FTE support personnel' all the personnel (in FTE) that is not directly involved in the caring for patients and that is assigned to the focused factory is meant. If this personnel works for departments with activities for focused and non-focused patients, their contribution to this measure is determined by the percentage of focused patients.

Support – Personnel		
Equipment		
inputs	**outputs**	**source**
total overhead costs	number of patients	
Personnel		
inputs	**outputs**	**source**
FTE support personnel	number of patients	

Figure 88: Support – equipment and personnel inputs and outputs with source

The information about the efficiency of the focused factory will be searched for in the following sources:

- Management information system
- Annual report 2005
- Work schedules
- Personal performed measures

Part five: Possible sources of information

General information hospitals
Hospital annual report 2005
Hospital website
Maybe interview manager orthopaedic department

Degree of focus
Manager orthopaedic department

Process alignment

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
mgr orthopaedic department	x	x	?				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
mgr operating room													x		x	x	x	x	x						x
mgr outpatient clinic															x	x	x		x						
mgr radiology department											x	x													
HRM employee				?	?	?																x	?		
mgt information system			x	x	x	x	x	x	x							x	x					x	x	x	x
annual report																							x	x	

Figure 89: sources of information for process alignment per question

Efficiency measures
Annual report 2005
Management information system
Work schedules
Personal performed measures

Part six Interview themes
The interviews will be held with these employees on the following subjects.

Manager orthopaedic department
- General information on the hospital
- Degree of focus
- Strategy and policy
- Protocols
- Relations with other departments
- Customers
- Staff
- Capacity use

Manager of the operating room
- Relation between operating room and focused factory
- Planning
- Process disturbance and cancelled appointments
- Capacity

Manager of the outpatient clinic
- Planning
- Process disturbance and cancelled appointments

Manager of the radiology department
- Relation between radiology department and focused factory

Part seven: Required Data (2005)

Number of…	**Knee**		**Orthopaedics**
	with implant	**without implant**	
Patients			
X-rays			
MRI-scans			
Outpatient clinic visits			
Operations			
- complete anaesthesia			
- regional anaesthesia			
Beds			
Inpatient days			
Discharges/ week			
Cancelled appointments			
Emergency treatments			
Average…			
Operating time			
Surgical time			
Preparation time			
Overhead costs			

Type of employees (FTE)	**Orthopaedics**	**Knee**
Orthopaedic surgeons (MD)		
Interns		
Nurses		
Operating room employees		
Anaesthetic employees		
X-ray department employees		
MRI-department employees		
Supporting departments employees (cleaning, technicians, etc.)		

	Hospital	**Orthopaedics**
Total number of employees (FTE)		
Percentage of temporary contracts		
Percentage of part-time contracts		
Percentage of absenteeism due to illness (excluding pregnancy)		

Appendix B: Results hospital 1

Focus results

Orthopaedic department
Focused Factory (joint care unit)
Orthopaedic department and Focused Factory (joint care unit)

Measuring the degree of focus on patients (patient group)
Question 1
How many of the ICD classification chapters describe your patients? Please consider the period of a year (preferably 2005). Only one answer possible.

a. one or two chapters (4)
b. three chapters (2)
c. more than three chapters (0)

Question 2
Each chapter of the ICD classification consists of a number of blocks. What percentage of blocks in the chapters indicated in question 1, describes your patients?

a. 0-20% (4)
b. 20-40% (3)
c. 40-60% (2)
d. 60-80% (1)
e. >80% (0)

Question 3
Please indicate how the variety in numbers of patients between blocks is perceived

a. very high (0)
b. high (1)
c. moderate (2)
d. low (3)
e. very low (4)

Question 4
How many ASA classes describe the patients receiving the care of your organization?

a. one or two ASA classes (4)
b. three ASA classes (2)
c. more than three ASA classes (0)

Focus on services offered (processes)
Question 5
How many specialties are involved in your organization?

a. one specialty (4)
b. two specialties (2)
c. more than 3 specialties (0)

Question 6

How many subspecialties are involved in your organization?

d. one subspecialty (4)
e. two subspecialties (2)
f. more than 3 subspecialties (0)

Question 7

Does your organization have its own (dedicated) radiology department?

a. Yes, we have our own radiology department (4)
b. No, but the radiology department is ours for the majority (90%) of the day (3)
c. No, but (part of) the radiology department is ours on specific (parts of) days (2)
d. No, but we have a higher priority at the radiology department (1)
e. No, the radiology department is a shared resource out of our control (0)
f. No, we don't use X-ray, CT or MRI in serving patients (not applicable) (4)

Question 8

We identify medical, surgical, and radiation treatments. We therefore distinguish between four types of services: 1) medical treatments, 2) surgical treatments, 3) radiation treatments, and 4) diagnostics. Please indicate how many of these types of services your organization offers

a. Only one of these types of services (4)
b. Two of these types of services (2)
c. More than two types of services (0)

Question 9

Please indicate, for each service your organization offers, which options applies.

medical

a. few medicines, few methods (4)
b. multiple medicines, few methods (3)
c. moderate medicines and methods (2)
d. Few medicines multiple methods (1)
e. Multiple medicines and methods (0)

surgical

a. < 50 different procedures (4)
b. 50-100 different procedures (3)
c. 100-250 different procedures (2)
d. 250-500 different procedures (1)
e. > 500 different procedures (0)

radiation

a. very high variety in treatment times (0)
b. high variety in treatment times (1)
c. moderate variety in treatment time (2)
d. low variety in treatment times (3)
e. very low variety in treatment times (4)

diagnostics

a. one or two diagnostics used (4)
b. three or four diagnostics used (2)
c. five or more diagnostics used (0)

Question 10

Please, indicate which option applies for your organization.

a. no patient has an ASA classification higher than 2 (4)
b. Less than 50% of the patients have an ASA classification equal to 3, no patients have an ASA classification higher than 3 (3)
c. more than 50% of the patients have an ASA classification larger or equal to 3, but no patients have an ASA classification equal or higher than 4 (2)
d. more than 25% of the patients have an ASA classification higher or equal to 4 (1)
e. more than 50 % of the patients have an ASA classification higher or equal to 4 (0)

Question 11

Please indicate which option applies for your organization.

d. more than 95% of all patients are treated inpatient or outpatient, with similar LOS (4)
e. more than 75% of all patients are treated outpatient, and inpatient LOS is < 5 (2)
f. less than 75% of all patients are treated either outpatient or inpatient (0)

Question 12

Please indicate which option applies for your organization.

a. more than 95% or less than 5 % of all patients are urgent cases (4)
b. other (0)

Production results per week

The following figures contain the production results per week of hospital 1. These production results are calculated by dividing the production results per year by 52.

Diagnostic phase

Per week	**Hospital**	**Orthopaedics**	**Knee**
Patients	3972,1	272,7	-
1st outpatient clinic visits	-	205,0	-
Outpatient clinic visits	-	447,3	-
X-rays	1146,2	286,5	89,8
MRI-scans	162,4	37,3	19,5

Figure 90: Whole hospital, orthopaedic department and knee patients production results per week hospital 1 (diagnostic phase)

Operation phase

Per week	Hospital	Orthopaedics	Knee
Operations	384,6	63,8	-
Endoscopies	-	-	-
Implants	-	12,3	4,5
Other operations	-	-	-

Figure 91: Whole hospital, orthopaedic department and knee patients production results per week hospital 1 (operation phase)

Post operative phase

Per week	Hospital	Orthopaedic department	Orthopaedic patients	Knee
Day-care	646,1	137,4	28,0	-
Nursing days	3007,0	296,8	200,6	-
Discharges	523,1	77,1	35,8	-
Average length of stay	5,7	3,85	5,60	-

Figure 92: Whole hospital, orthopaedic department, orthopaedic patients and other patients production results per week hospital 1 (post operative phase)

Support

Per week (*1000 Euro)	Hospital	Orthopaedics
Overhead costs	422,3	-

Figure 93: Whole hospital and orthopaedic department production results per week hospital 1 (support)

Appendix C: Results hospital 2

Focus results

Orthopaedic department
Focused Factory (knee patients (potential))
Orthopaedic department and Focused Factory (knee patients)

Measuring the degree of focus on patients (patient group)
Question 1
How many of the ICD classification chapters describe your patients? Please consider the period of a year (preferably 2005). Only one answer possible.

a. one or two chapters (4)
b. three chapters (2)
c. more than three chapters (0)

Question 2
Each chapter of the ICD classification consists of a number of blocks. What percentage of blocks in the chapters indicated in question 1, describes your patients?

a. 0-20% (4)
b. 20-40% (3)
c. 40-60% (2)
d. 60-80% (1)
e. >80% (0)

Question 3
Please indicate how the variety in numbers of patients between blocks is perceived

a. very high (0)
b. high (1)
c. moderate (2)
d. low (3)
e. very low (4)

Question 4
How many ASA classes describe the patients receiving the care of your organization?

a. one or two ASA classes (4)
b. three ASA classes (2)
c. more than three ASA classes (0)

Focus on services offered (processes)
Question 5
How many specialties are involved in your organization?

a. one specialty (4)
b. two specialties (2)
c. more than 3 specialties (0)

Question 6

How many subspecialties are involved in your organization?

a. one subspecialty (4)
b. two subspecialties (2)
c. more than 3 subspecialties (0)

Question 7

Does your organization have its own (dedicated) radiology department?

a. Yes, we have our own radiology department (4)
b. No, but the radiology department is ours for the majority (90%) of the day (3)
c. No, but (part of) the radiology department is ours on specific (parts of) days (2)
d. No, but we have a higher priority at the radiology department (1)
e. No, the radiology department is a shared resource out of our control (0)
f. No, we don't use X-ray, CT or MRI in serving patients (not applicable) (4)

Question 8

We identify medical, surgical, and radiation treatments. We therefore distinguish between four types of services: 1) medical treatments, 2) surgical treatments, 3) radiation treatments, and 4) diagnostics. Please indicate how many of these types of services your organization offers

a. Only one of these types of services (4)
b. Two of these types of services (2)
c. More than two types of services (0)

Question 9

Please indicate, for each service your organization offers, which options applies.

medical

a. few medicines, few methods (4)
b. multiple medicines, few methods (3)
c. moderate medicines and methods (2)
d. Few medicines multiple methods (1)
e. Multiple medicines and methods (0)

surgical

a. < 50 different procedures (4)
b. 50-100 different procedures (3)
c. 100-250 different procedures (2)
d. 250-500 different procedures (1)
e. > 500 different procedures (0)

radiation

a. very high variety in treatment times (0)
b. high variety in treatment times (1)
c. moderate variety in treatment time (2)
d. low variety in treatment times (3)
e. very low variety in treatment times (4)

diagnostics

a. one or two diagnostics used (4)
b. three or four diagnostics used (2)
c. five or more diagnostics used (0)

Question 10

Please, indicate which option applies for your organization.

a. no patient has an ASA classification higher than 2 (4)
b. Less than 50% of the patients have an ASA classification equal to 3, no patients have an ASA classification higher than 3 (3)
c. more than 50% of the patients have an ASA classification larger or equal to 3, but no patients have an ASA classification equal or higher than 4 (2)
d. more than 25% of the patients have an ASA classification higher or equal to 4 (1)
e. more than 50 % of the patients have an ASA classification higher or equal to 4 (0)

Question 11

Please indicate which option applies for your organization.

a. more than 95% of all patients are treated inpatient or outpatient, with similar LOS (4)
b. more than 75% of all patients are treated outpatient, and inpatient LOS is < 5 (2)
c. less than 75% of all patients are treated either outpatient or inpatient (0)

Question 12

Please indicate which option applies for your organization.

a. more than 95% or less than 5 % of all patients are urgent cases (4)
b. other (0)

Production results per week

The following figures contain the production results per week of hospital 2. These production results are calculated by dividing the production results per year by 52.

Diagnostic phase

Per week	Hospital	Orthopaedics	Knee
Patients	757,3	480,2	73,4
1st outpatient clinic visits	-	396,8	59,9
Outpatient clinic visits	-	804,6	208,0
X-rays	1262,2	-	119,3
MRI-scans	61,2	-	9,5

Figure 94: Whole hospital, orthopaedic department and knee patients production results per week hospital 2 (diagnostic phase)

Operation phase

Per week	Hospital	Orthopaedics	Knee
Operations	-	150,1	26,8
Endoscopies	-	-	12,1
Implants	-	-	7,2
Other operations	-	-	*7,5*

Figure 95: Whole hospital, orthopaedic department and knee patients production results per week hospital 2 (operation phase)

Post operative phase

Per week	Hospital	Orthopaedics	Knee
Day-care	-	112,3	11,9
Nursing days	-	483,8	109,7
Discharges	-	81,8	15,8
Average length of stay	-	5,92	*6,92*

Figure 96: Whole hospital, orthopaedic department and knee patients production results per week hospital 2 (post operative phase)

Support

Per week (*1000 Euro)	Hospital	Orthopaedics
Overhead costs	220,6	-

Figure 97: Whole hospital and orthopaedic department production results per week hospital 2 (support)