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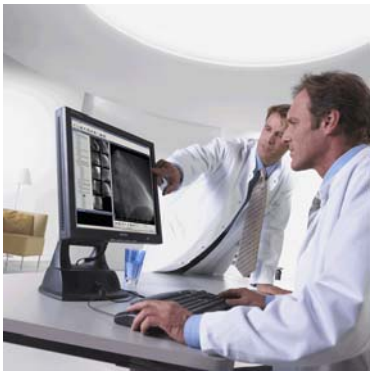
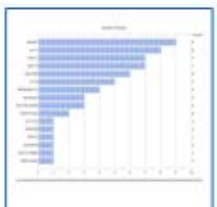
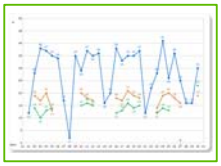
“Measuring Value”

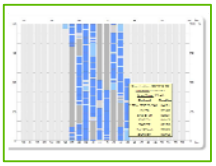
Crafting a Value Model for Kaizen Events for the MRI Scanning Process within Philips Healthcare

By G.J. van Viegen







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Report of a graduation project, to obtain the degree Master of Science, conducted from February 2009 till August 2009

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"Nowadays people know the price of everything

and the *value* of nothing"

- Oscar Wilde [1854 – 1900]
Anglo-Irish dramatist and poet


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Preface

This thesis is the end-result of a research project that I carried out for Philips Healthcare, part of Royal Philips Electronics N.V.. With this thesis, I conclude the finance track of the study Industrial Engineering and Management and will obtain the degree Master of Science.

The results presented in this thesis could not have been reached without the help of a number of people, whom I thank. Some people I thank in particular. First of all, I express my gratitude to the entire Philips organization, but especially to Milo Schoonheijm. The support that was provided to me from Philips is quite unique. Next to providing me with a laptop, arranging a residence for me in Eindhoven, providing the possibility to use the Philips pool cars and introducing me to dozens of people, I was given the opportunity to conduct case studies in four different countries.

Second, I thank my supervisors from Philips, Milo Schoonheijm and Andre van Est. Milo and Andre put huge effort in facilitating the research until the final end. Milo was the guardian of the project, by freeing up time for numerous progress meetings next to the continuous informal talks regarding the project. Andre, being a Kaizen consultant, provided me with great insights in Kaizen Events. The sessions where he shed his light on the Value Word Equations by always asking critical questions contributed greatly to the value model.

Third, I thank Murk, Rik, Milo, Martien and Wilhelm for the (almost) daily table soccer matches at Philips! This definitely helped me staying motivated and contributed in a positive matter to the end result. Overall, only positive things come to mind when I look back at my time at Philips.

Furthermore, I thank my supervisors from the University of Twente, Marc Wouters and Erwin Hans. Marc, being an expert in the field of value propositions, is responsible for the continuous improvements of this thesis by supporting me on the issues of methodology, literature and closing doors. Erwin specifically helped me to structure my research and aligning this thesis with the cost model thesis.

Finally, my word of thanks goes out to my relatives and friends. They supported me during my whole study period with the enjoyable times we had.

Pleasant readings,

Marcel van Viegen
Eindhoven, August, 2009


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Executive summary

Background

Royal Philips Electronics N.V. consists of three divisions: Healthcare, Consumer Lifestyle and Lighting. Within Healthcare, Philips offers utilization services for the MRI modality to its customers. One of these services is the Kaizen Event, which is a one week event at the customer site to improve utilization of the MRI scanner.

Objective

The Kaizen Event service has been offered in the market for one year, and is in the pilot phase. As a result, Philips has not yet focused on measuring and communicating the value for the customer of the Kaizen Event. By demonstrating the value for the customer, Philips shows that it understands the customer and that it is in the customer's best interest to buy the Kaizen Event service. In this context, the objective of this research is:

"To craft a value model for Kaizen Events for the MRI scanning process in healthcare facilities that explains how value is created and what the benefits are".

Value model

The Kaizen Event aims to reduce examination duration and has impact on productivity. The value model explains how value is created with the Kaizen Event by five Value Word Equations, which conceptualize examination duration reduction. The value model also explains what the benefits for the customer are. In case there is a waiting list for MRI exams, three benefits can be applicable: a monetary benefit due to increased reimbursement, a social benefit due to reduced access time and an external consultant benefit. In case there is no waiting list for MRI exams, three

benefits can be applicable: cost reductions, freed up time for other value adding activities and an external consultant benefit.

Cost model

Parallel to this research, a cost model was developed (Kuwornu, 2009) that functions as input for the value model. The cost model allows calculating the costs of different MRI exams of the healthcare facility and what the incremental costs for extra exams are.

Case studies

We conducted four case studies. The goal was to find out the usefulness of the value model in practice. For the case studies, we chose different types of healthcare facilities to find out differences in value creation. We chose different countries to find out how benefits differ. The most important results are:

Ziekenhuis Rijnstate (The Netherlands): an exam duration reduction of 09:10 minutes can be realized. This will lead to 5,052 extra MRI exams per year. The main benefit is access time reduction for patients.

Universitair Ziekenhuis Brussel (Belgium): an exam duration reduction of 07:40 minutes can be realized. This will lead to 3,254 extra MRI exams per year. The main benefit is a net value of € 310,824 in first year.

Institut für Radiologie Kapfenberg (Austria): an exam duration reduction of 01:00 minute was realized. This leads to 505 extra MRI exams per year. The main benefit is a net value of € 19,348 in first year.

Krankenhaus der Barmherzigen Brüder (Germany): an exam duration reduction of 04:05 minutes can be realized. This will lead to 660 extra MRI exams per year. The main benefit is access time reduction for patients.

We sent value propositions to the case study objects and enquired how convincing the value propositions are to them. The main feedback responses were:

"The five Value Word Equations are convincing and easy to understand for explaining the potential time savings in exam duration" *(Mr. Twilhaar, ziekenhuis Rijnstate, The Netherlands)*

"The average unscheduled time of 1 hour and 35 minutes is shocking and provides great insight for potential time savings" *(Mr. Twilhaar, ziekenhuis Rijnstate, The Netherlands)*

"The outlier analysis for conceptualizing patient-change-over time reduction makes sense. The 20 seconds reduction which is calculated for our facility is approximately accurate" *(dr. Sulzer, Institut für Radiologie Kapfenberg, Austria)*

Conclusions and recommendations

Our main conclusions are:

- The Value Word Equations are easy to understand and convincing. During the research and case studies we did not encounter any Kaizen Event improvements/recommendations that can not be captured with one of the five Value Word Equations. In that sense we conclude that the Value Word Equations succeed in explaining how value is created with a Kaizen Event.
- Regarding the different types of healthcare facilities, from the case studies we found that value is created with different Value Word Equations. We can not conclude a significant difference based on the four case studies, but nonetheless are the differences interesting to observe.
- Regarding the different countries, from the case studies we found that Belgium and Austria have a direct monetary benefit from extra MRI exams. For The Netherlands and Germany the monetary benefit is less clear due to

the more complex DRG reimbursement system. In these cases, the social benefit of a reduced access time for patients is the most interesting benefit.

Our main recommendations are:

- Approach potential Kaizen Event customer more proactively.
- Organize at least two comeback sessions in the first year the Kaizen Event takes place.
- The Philips Kaizen consultants should work more with SOPs and further develop the best practice MRI scanning process, so the Kaizen Event service can be further professionalized.
- Prior to conducting a Kaizen Event, map the healthcare facility's problems and place them in Van Houdenhoven's framework for hospital planning and control. This allows Philips to assess whether a Kaizen Event is the appropriate improvement method or a more radical improvement method is necessary.
- Introduce value-based pricing for Kaizen Events, since Philips can demonstrate and communicate the value for the customer with the value model.

Contents


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Introduction

The first part of this report functions as an introduction. This part contains the motivation for research, problem description, research objective, research questions and research methodology.


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Chapter 1

Research Design

The first chapter explains the need for a value model for Kaizen Events by describing the total offering of utilization services and describing experiences with customers (1.1). Then we formulate the problem (1.2), research objective (1.3), research questions (1.4) and we finish this chapter with the research methodology (1.5).

1.1 Motivation for research

Philips Healthcare Solutions has noted the current trend in the healthcare industry. The Deficit Reduction Act (DRA) in the United States of America and similar cost reduction moves around the world are likely to continue into the foreseeable future[a]. While governments and insurance companies are reducing their reimbursements to hospitals, there is also continuing social pressure on hospitals to improve quality and reduce waiting lists at the least possible cost. The consequence of this is that hospitals and other care-givers are demanding for more efficient solutions to their challenges in a cost-effective manner from their suppliers and partners. Competition, therefore, is becoming fierce in the healthcare equipment supply industry.

In response to the quality and efficiency demands of hospitals, Philips has rolled out its utilization services. These are services designed to help hospitals use the equipment bought from Philips more efficiently. To make the offering flexible, utilization services are made up of three tiers: Essentials, Advantage and Consulting. Under the Consulting services tier, there are three levels: Management Reviews,

[a] Centers for Medicare and Medicaid (www.cms.hhs.gov/DeficitReductionAct, July 2009)

Extended Quick Scans and Kaizen Events. The utilization services offering is shown graphically in Figure 1.1.

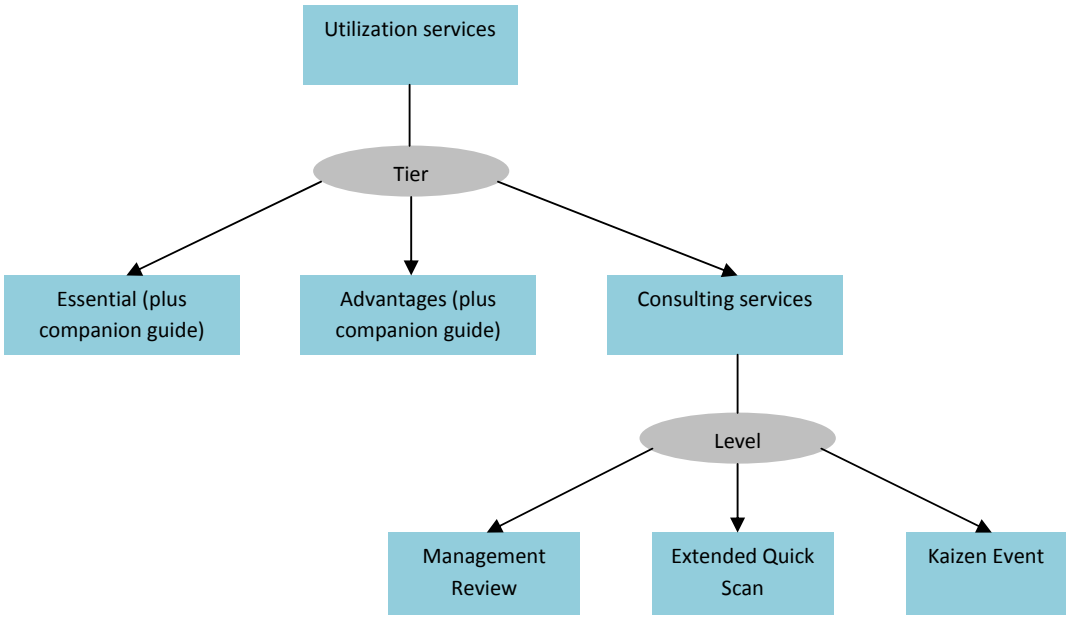

Figure 1.1: Philips utilization services

The first two tiers, Essentials and Advantages do not necessarily lead to improvements in the scanning process but demonstrate to clients that they could be more efficient. In fact they are like teasers. The actual improvement comes from the consulting services, especially the Kaizen Events. Philips places these services in the context of DMAIC (Define, Measure, Analyze, Improve, Control). DMAIC is a problem solving process as proposed by W. Edwards Deming in the 1950s, see Figure 1.2.

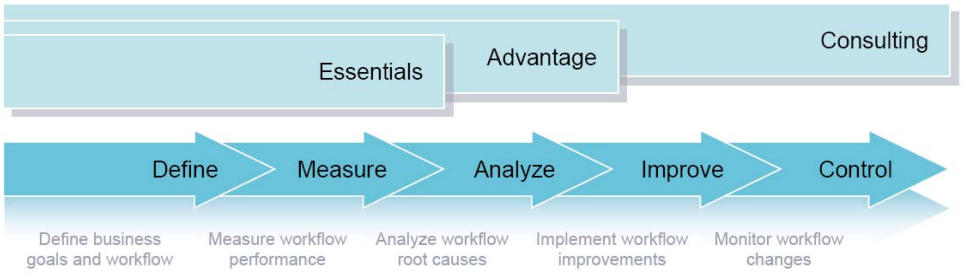

Figure 1.2: Philips utilization services with DMAIC cycle

Within consulting, Kaizen Events are consultancy services designed to help radiology departments reduce examination durations and thereby increase the number of examinations and/or save costs. Currently, the focus of this service is on MRI scanners. However, despite the enormous benefits of this service to clients, the patronage of this offering is below expectations. The Kaizen Events consultancy service began in 2008 and five has been conducted so far.

It stands to reason that radiology departments in hospitals and other imaging centres are missing the actual value in the Kaizen Events. Differently stated; Philips is not measuring and communicating the value of the offering to its clients. We therefore propose that the value of the Kaizen Events offered by Philips needs to be made more clear and concise in monetary terms as much as possible.

This view is supported by a former research performed at Philips Healthcare by Van der Heijden (2008). One of the research questions was related to what determines the buying decision for hospitals regarding utilization services. The finding was that this is determined by the price and how the price is being built; the benefits should outweigh the costs. By showing the value of the Kaizen Event clearly to the customer, in monetary terms where possible, Philips meets this customer demand.

For the reasons discussed above, Philips has initiated this project to be able to demonstrate the value of a Kaizen Event to the customer. Since the main purpose of the Kaizen Events consultancy service rendered by Philips is to help radiology departments reduce examination durations there is the need to show how examination durations are reduced and what the benefits of this are. In addition to this, we have to clearly demonstrate the cost implications of reduced examination time in the value proposition to the client. Therefore, two separate researches are conducted: one which digs into demonstrating the value (value model) and one which investigates the cost implications (cost model) of the Kaizen Event. In this research we develop the value model. We do refer to the cost model in this report where applicable.

1.2 Problem formulation

The combination of a value model and a cost model result in a solid value proposition for Kaizen Events for the MRI process in healthcare facilities[b]. We formulate the problem as:

"How can we develop a value proposition for Kaizen Events for the MRI scanning process in healthcare facilities that measures the value and cost implications of a Kaizen Event?"

1.3 Research objective

The value model measures how value is realized with Kaizen Events and what the benefits are for the healthcare facility. We formulate the objective as:

"To craft a value model for Kaizen Events for the MRI scanning process in healthcare facilities that explains how value is created and what the benefits are".

1.4 Research questions

The thesis is structured in three parts: in part I we search the literature on value definitions, value perspectives and value measurement. In part II we construct the value model. In part III we apply our value model at four healthcare facilities with a case study. Next we formulate the following research questions to attain the research objective.

[b] We define a healthcare facility to be an institution that could have an MRI scanner, like a hospital or private imaging centre

PART I:

1. How should value be defined for Kaizen Events for the MRI scanning process? (Chapter 2)

    a) How does the literature describe value?

    b) Where do value definitions differ?

    c) What perspectives on value can be distinguished?

    d) Which (part of which) value definitions and perspectives on value from the existing literature are appropriate for Kaizen Events for the MRI scanning process?

2. How should value be measured for Kaizen Events for the MRI scanning process? (Chapter 3)

    a) What different value frameworks exist in the literature?

    b) Which (part of which) value framework is appropriate for our value model?

PART II:

3. What is the appropriate model for measuring value for Kaizen Events for the MRI scanning process? (Chapter 4)

    a) Where in the MRI scanning process is value created?

    b) On what critical processes within the MRI scanning process does the Kaizen Event focus and how does Philips measure the performance of these processes?

PART III:

4. How well does the value model explain how value is created and what the benefits are, and can the suggested method be used for a value proposition in practice? (Chapter 5)

1.5 Research methodology

This paragraph focuses on the research methodology that we follow in order to arrive at the research objective. We conduct both desk research and field research.

1.5.1 Desk research

Desk research, also known as secondary research, involves gathering data that already exists. Sources can be internal company documents, publications of governmental and non-governmental institutions, data on the internet, professional magazines and annual reports. Advantages of desk research are:

1. Large amounts of information can be retrieved
2. Cheap
3. Time effective

We conduct desk research for finding answers to research questions 1, 2 and 3. We analyze all the relevant literature pertaining to the scope of our research. The two major subjects for which we search the literature are “value definitions” (chapter 2) and “value measurement” (chapter 3). We then build our value model (chapter 4) by making use of our findings from the literature and the NetForum[c] database.

1.5.2 Field research

Field research, also known as primary research, involves the collection of primary data. These data can be collected through participant observation, surveys or questionnaires. Advantages of field research are:

[c] NetForum is the brand name for the internal Philips database that contains remotely gathered data regarding the MRI scanner(s) of the customer

1. More freedom in what information can be gathered
2. Gathered information is up-to-date

We conduct surveys for finding the answer to research question 4 by conducting case studies. During the case studies we conduct interviews with different staff of the healthcare facilities. The interviewees are: planner/scheduler, manager, radiologist, technologist and employee finance & accounting. We use semi-structured interview technique.


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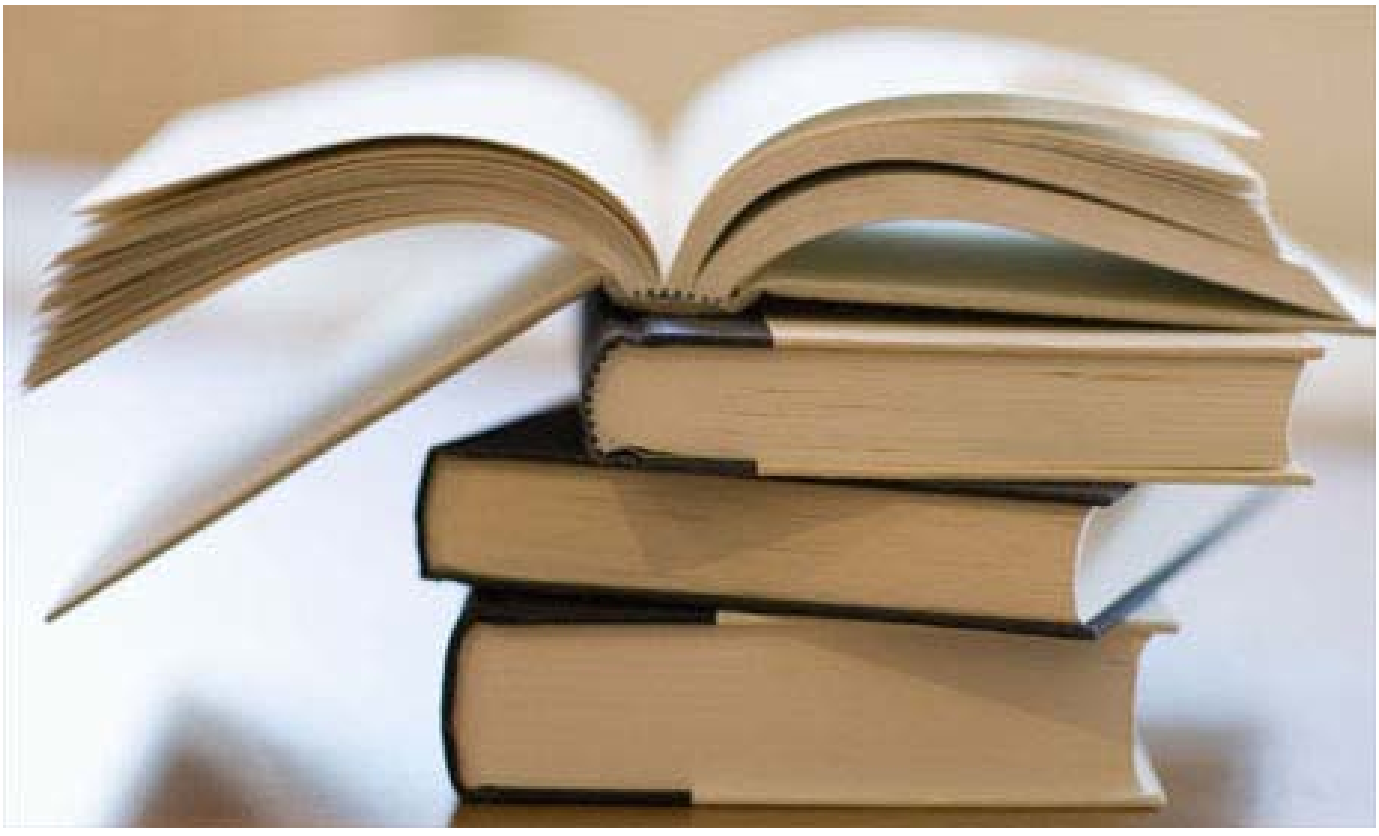
Part I: Literature Study

The first part of the report studies the existing literature on value. This part elaborates on value definitions, measuring value, and value frameworks.

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Chapter 2

Literature on Value Definitions

Before we can decide how to measure value for Kaizen Events, we have to understand the concept of value. This is what we do here. We start this chapter with describing the method of the literature study for this chapter and the next (2.1) and the history of value theory (2.2). Then we investigate the literature for value definitions (2.3) and different perspectives on value (2.4). We conclude with a value definition for Kaizen Events for the MRI scanning process (2.5).

2.1 Method of the literature study

In this section we describe how we conduct the literature study in chapter 2 and chapter 3. We use top down as well as bottom up literature searching.

For top down searching we use the search engines “web of science”, “sciencedirect” and “scopus”. We also search “Google Scholar”, although there is uncertainty surrounding its coverage. We still find Scholar useful for completing the literature study by only using papers with many citations (100+). We use the following search criteria: “business value”, “value business markets”, “customer value”, “consumer value”, “perceived value”, “value satisfaction”, “value quality”, “value benefits sacrifices”, “measuring value”, “managing value”.

For bottom up searching we use forward citation analysis and backward citation analysis. Backward citation entails investigating references while with forward citation we find papers that cite papers we have found. Besides papers we use three books directly related to the research: “Value merchants”, “Know your customer” and “Healthcare in Europe: the finance and reimbursement systems of 11 European countries”.

2.2 Origins of value theory

Driven by more demanding customers and global competition, many organizations are on a journey, searching for new ways to achieve and retain competitive advantage. With quality management, managers learned how to improve the quality of both their organization's internal operations and processes. These efforts brought important performance improvements, but, ironically, too often they reinforced an internal orientation. Most quality tools help managers make internal process improvements (Woodruff, 1997).

From the mid-1950s, marketing academics started to advocate that firms achieve their organizational goals through creating, delivering and communicating value to their chosen target consumer markets more effectively than their competitors (e.g. Borch, 1957; Keith, 1960; McKitterick, 1957).

However, it was only in the 1990s that the search for a precise definition of value found the attention of a broad spectrum of researchers. The phenomenon was even less appreciated in the business-to-business professional services context, where value was not defined and researched until 1997 when Lapierre (1997) started the research.

In 1997 Bradley Gale observed: "…when we delve into the measurement-analysis-understanding-acceptance-improvement sequence, we find two complementary paradigms: the customer satisfaction paradigm and the customer value paradigm. The customer satisfaction paradigm is older … The customer value paradigm is newer, includes many of the elements of the customer satisfaction paradigm plus additional features, and is being more widely adopted and deployed" (Gale, 1997).

Investigations of Giese and Cote (2000) and Robinson (1999) imply that the 1980s represented the era of satisfaction; that interest in service quality peaked around 1994/1995, but that customer value is currently pre-eminent and likely to remain so for some while.

There is little doubt that academics and the business community alike have acknowledged the growing importance of a newly dominant concept (e.g. Goodwin and Ball, 1999; Sweeney, Soutar and Johnson, 1999). Recent commentators imply a pivotal and highly influential role for a property that has been gaining in interest to both managers and researchers (Parasuraman, 1997); that has been called the new 'marketing mania' (Sinha and DeSarbo, 1998); and that represents the foundation for true customer loyalty (Reichheld, 1996).

2.3 Value definitions from the existing literature

Different authors attempted to define the concept of value in recent decades. Up until now there seems to be some consensus as to defining value, but still different views exist. For that reason it makes sense to start with presenting different definitions. Value is a term that is applicable for customers. The main two different types of customers are: (1) consumers, and (2) professional customers. The consumer market is called business-to-consumer (B2C) and the professional customers market is called business-to-business (B2B). Kaizen Events are in the B2B sphere. We do not start are journey for value definition with this split-up because not all authors are specific about for which type of customers their definition is applicable. In section 2.5.2 we find out what elements of all existing value definitions are suitable for B2B markets and, specifically, for Kaizen Events.

Zeithaml (1988) discusses perceived value, the concept of value from the consumer's perspective. It is defined as superiority or excellence: *"Perceived value is the consumer's overall assessment of the utility of a product based on perceptions of what if received and what is given. Though what is received varies across consumers (i.e. some may want volume, others high quality, still others convenience) and what is given varies (i.e. some are concerned only with money expended, others with time and effort), value represents a trade-off of the salient give and get components"*. The "gets" are the benefit components of value including salient intrinsic attributes,

extrinsic attributes, perceived quality, and other relevant high level abstractions. The "gives" are the sacrifice components of perceived value including monetary prices and non-monetary prices (Zeithaml, 1988).

Kotler and Keller (2006) define customer perceived value as follows: *"Customer perceived value is the difference between the prospective customer's evaluation of all the benefits and all the costs of an offering and the perceived alternatives."* Total customer value is the perceived monetary value of the bundle of economic, functional, and psychological benefits customers expect from a given marketing offering. Total customer cost is the bundle of costs customers expect to incur in evaluating, obtaining, using, and disposing of the given market offering, including monetary, time, energy, and psychic costs (Kotler and Keller, 2006).

Gale (1994) includes perceived quality in his definition: *"Customer value is market perceived quality adjusted for the relative price of your product"* (Gale, 1994).

Anderson, Kumar and Narus (2007) define customer value in business markets: *"The worth in monetary terms of the technical, economic, service and social benefits a customer firm receives in exchange for the price it pays for a market offering"* (Anderson, Kumar and Narus, 2007). They state that value is what a customer firm gets in exchange for the price it pays. Raising or lowering the price does not change the set of benefits that an offering delivers to customers, only the willingness of those customers to purchase the offering. Thus, conceptually a marketing offering can be viewed as having two elemental characteristics: its value and its price.

2.3.1 Some areas of consensus

At a first glance, commonalities among these definitions stand out. For instance, customer value is inherent in or linked through the use to some product or service.

In addition, customer value is something perceived by customers rather than objectively determined by a seller.

Finally, these perceptions typically involve a trade-off between what the customer receives (e.g. quality, benefits, worth, utilities) and what he or she gives up to acquire and use a product (e.g. price, sacrifices).

2.3.2 Some areas of divergence

Delving deeper into customer value concept discussions reveals substantive meaning differences. One difference lies in the way definitions are constructed. They typically rely on other terms, such as utility, worth, benefits and quality. That makes it difficult to compare concepts.

Furthermore, one could for example ask if a certain benefit would be the same for every customer, or that this depends on individual preferences or even the context in which the benefit is being perceived.

Some authors mention product or service explicitly in their value definition, but no clear arguments are made why that would go for a service or product and if the proposed concept can be generalized for products and services.

A final point of divergence that should be mentioned is the way price is being put in the value definitions. Some authors state that value is dependent on the offered price, while others argue that price does not change the value of an offering.

2.3.3 Conclusion

Now that we understand the differences among value differences, we need to further elaborate on perspectives in value literature before we formulate the value definition for Kaizen Events for the MRI scanning process. Exploring these

differences leads to a deeper understanding of customer value. Later on in section 2.5.1, when we understand all perspectives in the literature from section 2.4, we have a more thorough discussion on value definitions in the existing literature, and formulate the appropriate value definition for Kaizen Events for the MRI scanning process.

2.4 Perspectives on value in the existing literature

In this section we obtain a deeper understanding of customer value by delving into the deeper layers of value, besides the value definitions we presented in the previous section. After this section we understand which elements of value are appropriate for Kaizen Events and are ready to formulate the value definition for Kaizen Events.

2.4.1 Supplier value and buyer value

Lindgreen and Wynstra (2005) and Payne and Holt (2001), among others, elaborate on buyer-supplier relationship marketing and distinguish between supplier value and buyer value. The distinction is made to portray both what is derived by the customer from the supplier, and also what is derived by the supplier from the customer.

2.4.2 Perceived value

Lapierre (1997) and Kotler (2006), among others, discuss perceived value, more specific, customer perceived value. This perspective elaborates on which elements most affect the perceived value for the customer. The term perceived further implies that individuals perceive value in a different way; otherwise the term customer value would suffice.

2.4.3 Relationships to quality, satisfaction and repurchase/loyalty

There is extensive literature on the relationship between value and quality, satisfaction and buyer behaviour. Lapierre, Filiatrault and Chebat (1999) discuss value, quality and satisfaction in one article and find the effects on re-buy intentions. Some authors suggest that perceived quality is an antecedent that has a positive effect on perceived value (Cronin et al., 2000; Lapierre et al., 1999), whereas others contend that quality is a sub-component of overall value (Holbrook, 1999; Sweeney and Soutar, 2001).

Regarding quality, Zeithaml (1988) states that value is more individualistic and personal than quality. Furthermore, quality is an antecedent to perceived value and thus a component of value (Oliver, 1996; Ho and Cheng, 1999). Assessing the quality of a service is also discussed in the value literature. Lapierre (1993) identifies some dimensions that organizational customers of consulting engineers mostly use when assessing the quality of these services. This is also reflected in the body of research on professional service quality (e.g. Cravens, Dielman, and Harrington, 1985).

About the repurchase decision Butz and Goodstein (1996) say, among others, that customers make repurchase decisions based on future predictions of value determined via experience; customers are loyal when value is delivered.

Regarding the relationship to satisfaction the main view is that satisfaction is achieved when a company delivers value (Slater, 1997; Walters and Lancaster, 1999). This means that value is an antecedent to customer satisfaction (Fornell, et al., 1996; Bolton and Drew, 1991). Hallowell (1996) suggests that satisfaction is the customer's perception of the value received in a transaction or relationship. Whether a customer is satisfied depends on the expectations and actual result.

2.4.4 Different forms of buyer value

Previous sections explained that the literature describes a broad distinction between supplier value and buyer value. Woodall (2003) focuses on the customer (buyer) value, called Value for the Customer (VC), and differentiates between five different forms of buyer value. The main reason for this is because Woodall found eighteen different names for similarly-described, demand-side notions of value in the literature. Since this remains an area of continuing ambiguity, Woodall attempts to provide an anchor by classifying different forms of value. This should lead to uniformity of value language in future research. We outline the different forms with a brief explanation next.

Marketing VC:	Perceived product attributes
Sale VC:	Option determined primarily on price
Rational VC:	Monetary difference from objective reference point
Derived VC:	Use/experience outcomes
Net VC :	Balance of benefits and sacrifices

2.4.5 Creating and delivering value

The area of superior customer value creation and delivery has been the focus of much research interest in the 1990s (e.g. Band, 1991). This work is closely aligned with the calls for organizations to become more market and customer-focused with strong influences from the market orientation strategy literature. The emphasis of this work is on the linkages between customer value and organizational profitability, performance and competitive advantage, and argues that a company's success depends on the extent to which it delivers to the customer what is of value to them (Payne and Holt, 2001). This resulted in different framework for how to manage customer value.

2.4.6 Moment of value realisation

There is also attention in the literature for the moment in time of value realisation. Two main value creation moments can be distinguished: on the one hand, Beckman (1957) argues in terms of value-in-exchange, and bases his calculation of value adding upon “the selling value” of products. On the other hand, Alderson (1957) reasons in terms of value-in-use.

Lapierre (1997) puts these two moments of value realisation into one conceptual model that describes the process of value creation over time.

2.4.7 The idiosyncratic aspect of value

Holbrook and Corfman (1985) argue that the value of a service depends, among other things, on the tastes and characteristics of the customer. Value is therefore personal and idiosyncratic (Livingstone and Zeithaml, 1987). The implication of this is that the value of an offering is not the same for everyone and cannot be generalized.

The idiosyncratic aspect of value is closely related to customer perceived value, which was discussed earlier. Perceived value depends on characteristics of the customer.

2.4.8 Comparison with next-best alternative

Some authors state that the value of an offering should always be compared to the next-best alternative. According to Anderson, Kumar and Narus (2007) this can be another offering of the same supplier, the competitor’s offering, or even doing nothing.

2.4.9 Needs and expectations

With regard to the needs and expectations components of perceived service value, Brandt (1988) explains that perceived value is the response to needs determined by the customer's situation and cost constraints. The mass market service literature explains that value always originates a person's needs system (Connor and Davidson, 1985); it is a function of a person's identified needs which are satisfied in a way that meets his expectations. This view is supported by Holmlund and Kock (1995), who state that good service quality [value] is formed when the supplier knows the buyers' needs and develops and adjusts the problem solution so that is meets these needs.

2.4.10 Value as a strategy

Should companies focus on value strategy of quality strategy? An answer to that question is given by Lapierre, Filiatrault and Chebat (1999). They explain how to use value as a strategy by identifying points where value is being created for a certain business or consumer market and then adjusting the offerings to the identified needs of the market. The conclusion is that the focus should be on value strategy since value is determined by both quality and total price.

2.4.11 Discussion of different perspectives in the existing literature

The literature shows so many different perspectives and definitions on value that it is probably true that there no single answer to the question "what is value?". Regarding value, one enters a very complex terrain, on the crossing of economics, strategy, finance, management, sociology and philosophy. Next we discuss the different perspectives on value, which were explained in this section.

This research focuses on the value for healthcare facilities, i.e. buyer value. We assume that the value to the supplier (Philips) is already known.

Perceived value and the idiosyncratic aspect of value are closely related. We conclude that these aspects are typical for the B2C market. These are therefore excluded from the value definition for Kaizen Events for the MRI scanning process.

Different forms of value are identified. The term Net VC does explain exactly the same type of value as the demand-sided customer value we talk about, namely the difference between benefits and sacrifices for the customer. The differentiation is mainly intended for uniformity of language in future research. For this reason we use the term Net VC in our value definition.

Creating and delivering value is a process prior to measuring value. Since Philips has already positioned an offering in the market, the Kaizen Events, there is no need to manage value in the way described by creating and delivering value.

Regarding the moment of value realization we state that the value of Kaizen Events will only show with time and thus can be compared to value-in-use. Kaizen Events is not a goal by itself so there will be little value created during the exchange of the service. The service is a means to an end.

The Kaizen Event offering should be compared with doing nothing, since it is the first service in its kind so it cannot be compared with a previous service. Furthermore, the danger of competitors coming with a similar service is not high for one major reason, which is the unavailability of remotely collected data. Philips has connected the MRI scanners via a VPN to its own database and retrieves data. Competitors do not have access to these data. This gives a major competitive advantage for offering Kaizen Events.

With regard to needs and expectations holds that the Kaizen Events market is not a mass market. It is a service tailored to the specific process of a healthcare facility. This means that value does not necessarily originate in an organization’s needs

system. We assume that healthcare facilities do not weigh needs and expectations in their value perception and thus can be excluded from the value definition.

We embrace the idea of having a value oriented strategy compared to a quality strategy. This however does not affect our value definition.

Earlier we already determined that quality is an antecedent of value and should therefore be excluded from our value definition. Satisfaction is achieved when a company delivers value and is thus an antecedent to value. Furthermore, when great value is delivered, customers tend to be more loyal and have repurchase intentions. For the value definition these aspects are not relevant, but become interesting when the service has been offered.

2.5 Towards a value definition for Kaizen Events for the MRI scanning process

The previous sections identified existing value definitions and different perspectives within the value literature. To formulate the appropriate value definition for Kaizen Events for the MRI scanning process, we have to discuss value definitions from the existing literature in detail (2.5.1). Then we discuss the differences in B2B and B2C markets separately (2.5.2) to arrive at the value definition for Kaizen Events in the MRI scanning process (2.5.3).

2.5.1 Discussion of existing value definitions

Different terms are used to describe value. The most commons ones are utility, worth, benefits and quality. After studying the literature we conclude that quality is a component of value. Furthermore, there is no consensus about the other components of value and if they can be generalized for products, services or even

different markets. The term utility is commonly used in the field of economics to describe relative preference of different products or services. This could be a good indicator of value. However, Anderson, Kumar and Narus (2007) state that they have never heard a business manager talk about utility and should therefore be discarded from the value definition. Worth and benefits are more appropriate terms. There will not be much confusion regarding benefits among individuals. The term worth is most meaningful when expressed as an objective measure, such as the worth in monetary terms of an offering.

Should price be included in the value definition? In other words, should the value of an offering depend on the price of that offering? We agree with the view of Anderson, Kumar and Narus (2007) that in business markets the price should only be used for comparison with the worth of the offering. We conclude that if the worth of the offering is greater than the sacrifices, there is value. Price should be excluded from the value definition.

Another point of divergence is how product value and service value differ and what the differences are in how they should be measured. Heskett, Sasser and Hart (1990) argue that what a customer gets for what he pays forms the basis for measuring the value of a service just as it does for the value of a product. Value in a service results in part from quality. Improving quality is the best way to give the customer better value (Day, 1990). Specific differentiations between product value and service value are not discussed in the literature. As long as the value definition is kept general it can be used to capture both product value and service value.

The remaining aspect is the way value is being perceived by individuals. We argue that the difference between perceived value and objective value lays in the nature of the market: business-to-consumer or business-to-consumer. It is interesting to investigate the differences between these markets with respect to value. The literature does not describe this aspect thoroughly. Therefore, we attempt to pinpoint the differences for these markets next.

2.5.2 Differences in value definition between B2B and B2C markets.

As mentioned in section 2.3, we distinguish between value in B2B and B2C markets. We find that in the existing literature there is no consensus in the differences in value in B2B and B2C markets. We therefore attempt in this section to formulate differences in value definition for B2B and B2C markets. This is helpful for our value definition for Kaizen Events, since the Kaizen Event is an offering within the B2B market. To avoid confusion, customers in the B2B sphere we call "professional customers" and customers in the B2C setting we call "consumers". In the next paragraphs we put the differences in terms of sacrifices, benefits, context, and needs and expectations.

Sacrifices

One of the points of consensus within value definitions is that value is being perceived by the difference between the benefits ("gets") and sacrifices ("gives"). To start with, consumers differ in the way they perceive sacrifices. Results from Zeithaml's (1988) pilot study show that for some customers whatever can reduce the monetary price contributes to increasing the perceived value. However other customers, who are less price conscious, perceive value in terms of other sacrifice factors, such as proximity, delivery etc., even at the expense of higher price, because the time and effort involved are perceived as more costly. Thus, it is not true that consumers are trying only to minimize price (Monroe, 1982). Downs (1961) summarizes this in his theory of customer efficiency by stating that customers try to minimize three types of costs associated with consumption: money, time, and effort. These three types of costs do not all have the same importance for all customers and for all purchases.

We can even go one step further and argue that price, which in itself is a sacrifice, can be perceived as a benefit to some consumers. We can all imagine examples of upper class demographic groups who perceive higher value of jewellery when the price is increased, because that demonstrates higher value to their peers. Obviously

this only goes for situations when spending more money does not result in a trade-off for your other needs. This example can be the case in consumer markets.

Considering that companies strive for profit (in a more or less way), professional customers should focus on minimizing the money attribute of the sacrifices, while putting time and effort as a constraint in the equation. The assumption that follows from this is that different healthcare facilities are evenly willing to put time and effort in acquiring the Kaizen Event and are looking for minimizing the price.

Benefits

Holbrook and Corfman (1985) argue that the value of a service depends, among other things, on the tastes and characteristics of the customer. Holbrook (1994, 1996, 1999) therefore proposed a 'typology of consumer value' based on three dichotomies. Then combined in all possible combinations, these three distinctions produce eight types of value. A crucial aspect of Holbrook's argument is that all eight types of perceived value tend to occur together to varying degrees – in any given consumption experience.

Regarding B2B value, Dart (1995) and Saporta (1989) state that a buyer does not buy a professional service for its own sake: he buys a service with a view of improving the performance of his organization; he is looking for competitive advantage.

It seems logical that professional customers have less disagreement on different benefits, since there are no individual tastes and characteristics among business of benefits; all companies prefer more profit, more market share and more satisfied customers. The assumption we would like to make here is the benefits of the Kaizen Event are not being perceived differently for different healthcare facilities. This means that the benefits in our value model are valued (approximately) the same by all healthcare facilities.

This implies that professional customers do not perceive value differently but consumers do. Therefore, in the remainder of this research we talk about "customer value" and not about "customer perceived value".

Context

Holbrook and Corfman (1985) maintain that value perceptions are situational. Zeithaml (1988) agrees that value is context dependent. This means that "when" and "where" the offering is being purchased influences the perceived value. Both authors give examples of this for the consumer industry. One could for example imagine that consumers who buy ice cream in the winter perceive the value differently than when being bought in summertime.

We assume that the value of Kaizen Events does not change with time or location, so is not context dependent.

Needs and expectations

Regarding the needs and expectations components of perceived service value, Brandt (1988) explaines that perceived value is the response to needs determined by the customer's situation and cost constraints. Mass market service literature explains that value always originates a person's needs system (Connor and Davidson, 1985); it is a function of a person's identified needs, which are satisfied in a way that meets his expectations (Engel et al., 1986).

The Kaizen Event market is not a mass market; it is a service tailored to the specific process of a healthcare facility. This means that value does not necessarily originate in an organization's needs system. We assume that healthcare facilities do not weigh needs and expectations in their value perception and thus can be excluded from the value definition.

2.5.3 Value definition for Kaizen Events for the MRI scanning process

At this point our understanding of the concept of value allows us to define value for Kaizen Events for the MRI scanning process.

The *value for a healthcare facility* (Net VC) related to a Kaizen Event for the MRI scanning process is the difference between what is received (the worth), and what is given, expressed in monetary terms where possible, compared to the situation without a Kaizen Event (doing nothing).

The *incentive to purchase* for a healthcare facility is the difference between the Net VC and price of a Kaizen Event.

The customer value definition has some terms that more detailed explanation. Net VC is Net Value for the Customer as defined by Woodall (2003). The reason that we use this is because we try to create uniformity for value language in future research as explained earlier. “What is received”, or “the worth”, is not very clear in itself. What we mean by that is all the benefits that are achieved as a result of the Kaizen Event. “What is given” incorporates all the sacrifices the healthcare facility has to make in order to make the Kaizen Event to a success.

2.6 Conclusion

In this chapter we investigated the existing literature for value definitions and value perspectives. We defined value for Kaizen Events for the MRI scanning process by taking elements from existing value definitions and value perspectives that are suitable for B2B markets. The value definition for Kaizen Events for the MRI scanning process is:

“The *value for a healthcare facility* (Net VC) related to a Kaizen Event for the MRI scanning process is the difference between what is received (the worth), and what is

given, expressed in monetary terms where possible, compared to the situation without a Kaizen Event (doing nothing).”

The *incentive to purchase* for a healthcare facility is the difference between the Net VC and price of a Kaizen Event.

Chapter 3

Literature on Value Measurement

The goal of this chapter is to find out how we should measure value with our value model. We start with an introduction to value measurement (3.1). Then we find existing value frameworks from the literature and qualitative research methods for collecting data for our case studies (3.2). We conclude with summarizing which parts of the described value frameworks we use in our value model (3.3).

3.1 Introduction to value measurement

Some articles focus on measurements of value exchange. Like Lapierre, FiliaTrault, Chebat (1999), who argue that service quality can be captured by the attributes competence, reliability and communications. Sacrifices are captures by cost fairness, time and effort.

We however, are interested in measuring so called value in use, as defined by Lapierre (1997). The term value in use describes the value that becomes apparent later in time. This is exactly what happens with a Kaizen Event; the actual service exchange does not bring any value, it is just a means to an end.

At this point in time there is still lack of unanimity concerning measuring value. Gale (1994), perhaps the first to attempt quantification of value in a marketing context, uses a mapping process that enables a supplier to benchmark the value of its market offering with that of its competitors through a comparative review of customer's perceptions regarding both product price and quality.

Tzokas and Saren (undated), however, argue that customer value is a dynamic and transformational higher level construct which should not be reduced to a low-level operational measurement.

Such criticism would bring about a robust exchange from Anderson and Narus (1998) for whom value is stated simply in terms of dollars and hours, but would align more easily with a Woodruff and Gardial (1996) perspective that relies on excavatory means-end laddering techniques to unfold evidence of consumers' deepest desires.

3.2 Different value framework perspectives from the literature

The goal of this framework analysis is finding all the attributes and elements that capture value. In section 3.3 we decide which attributes and elements of the existing frameworks we use for our value model for Kaizen Events for the MRI scanning process.

3.2.1 Woodall's benefits and sacrifices

Woodall (2003) has done an extensive effort on finding value benefit attributes and value sacrifice attributes. His general framework is presented in Figure 3.1 and a table with more detailed attributes is presented in Table 3.1. These second-level, more concrete, attributes we will refer to as "elements" in this research. "Net VC" as mentioned by Woodall in Figure 3.1 stands for "Net Value for the Customer" of which the meaning was explained in section 2.4.4.

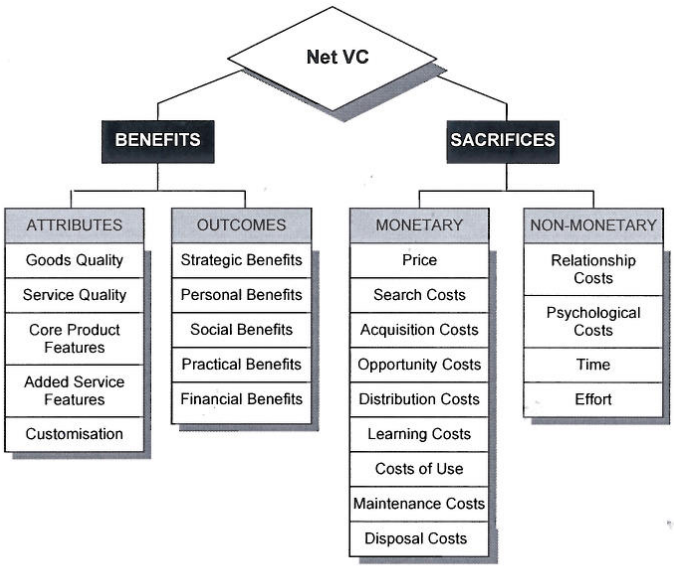

Figure 3.1: Benefits and sacrifices (Woodall, 2003)

Woodall states that, although each organization's value proposition will be unique unto itself, generically it is likely to be made up from those attribute categories shown in the extreme left-hand column in Figure 3.1.

BENEFITS		SACRIFICES
Attributes	Outcomes	
Perceived quality	Functional benefits	Price
Product quality	Utility	Market price
Quality	Use function	Monetary costs
Service quality	Aesthetic function	Financial
Technical quality	Operational benefits	Costs
Functional quality	Economy	Costs of use
Performance quality	Logistical benefits	Perceived costs
Service performance	Product benefits	Search costs
Service	Strategic benefits	Acquisition costs
Service support	Financial benefits	Opportunity costs
Special service aspects	Results for the customer	Delivery and installation costs
Additional services	Social benefits	Costs of repair
Core solution	Security	Training and maintenance costs
Customisation	Convenience	Non-monetary costs
Reliability	Enjoyment	Non-financial costs
Product characteristics	Appreciation from users	Relationship costs
Product attributes	Knowledge, humour	Psychological costs
Features	Self-expression	Time
Performance	Personal benefits	Human energy
	Association with social groups	Effort
	Affective arousal	

Table 3.1: Benefits and sacrifices (Woodall, 2003)

3.2.2 Lapierre's value attributes

Lapierre (1997) identifies value attributes for professional services, and split-up the attributes based on when the value is being realized. The first level is value exchange and the second level value in use. The attributes are listed in Table 3.2.

First level (value exchange)	*Second level (value in use)*
Technical quality	Financial
Reliability	Cost reductions
Information understandability	Revenues
Information practicality	Profitability
Technical expertise	Rentability
Specialized expertise	Social
Creativity	Reduce accident rates
Functional quality	Save lives
Integrity	Improve standard of living
Responsiveness	Operational
Professionalism	Productivity
Relational variables	Product development and deployment
Partnership	Facilitate operations
Involvement	Strategic
Confidence	Better decisions
Image	More enlightened decisions
Reputation	
Credibility	

Table 3.2: Lapierre's value attributes

3.2.3 Anderson's Value Word Equations

Anderson, Kumar and Narus (2007) start their journey of measuring value with their "fundamental value equation":

$(Value_f\text{-}Price_f) > (Value_a\text{-}Price_a)$,

in which $Value_f$ and $Price_f$ are the value and price of a particular firm's market offering, and $Value_a$ and $Price_a$ are the value and price of the next-best-alternative market offering.

Anderson suggests starting with listing the value elements. Value is being realized through technical, economic, service and social benefits. Listing value elements is about listing all elements that distinguish your marketing offering from the next-best-alternative. In the case of a competitor, this should include also unfavourable elements, since this would prevent undermining the credibility of the value proposition. In our case however, the next-best-alternative is considered to be doing nothing, so there are no unfavourable elements. By being as elemental as possible, the supplier firm is able to more accurately gauge the differences in functionality and performance its offering provides. For example, "provision of technical services" is according to Anderson too broad to enable a supplier to understand specifically how this element reduces customer costs. Answers to broadly formulated value elements often will leave out effects on the customer's business processes, producing less-valid estimates of worth.

When there is not yet a concrete market offering formulated, Anderson suggests four questions that generate some creative ideas. However, in our case the market offering is already there, namely the Kaizen Events for the MRI scanning process.

When the market offering is clear and all value elements are identified, it is time for constructing "Value Word Equations" (VWEs), which is central to customer value management. It is expressing the technical, economic, service and social benefits that a customer firm receives from a supplier's offering in monetary terms. A value

word equation expresses precisely in words and simple mathematical operations (e.g. +, x) how to assess the functionality or performance of the supplier's market offering. Doing this in practice is not easy and takes time, money, persistence and some creativity. Yet, businesses must tackle this challenging task if they wish to become value merchants.

The data for the Value Word Equations is most often collected from the customer's business operations by supplier and customer managers working together, but at times, data may come from outside sources, such as industry association studies.

3.2.4 Woodruff and Gardial's qualitative research methods

In their book "Know your customer", Woodruff and Gardial (1996) devote a chapter to measuring value. They describe three qualitative methods for gathering customer data for measuring value: observation, focus groups, and in-depth interviews. Next we provide an overview of the key issues involved in deciding between and implementing each method.

This decision need not be an "either/or" situation. In some cases, managers may be able to use multiple qualitative techniques. More likely, however, time and money considerations will dictate that only one technique is chosen.

Observation

If a picture is worth a thousand words, a few hours of observation may be worth a thousand survey responses. An advantage of this method is that it does not take much time and effort from the customer.

Focus groups

With this method, a small group of customers are gathered to discuss their product experiences with the aid of a moderator or facilitator. One of the primary advantages of this method is the potential for synergy among the participants,

where one participant's comments may stimulate discussion and a snowballing effect of ideas among others. Some participants may also feel more at ease in a group format that in one-on-one format where they are the sole focus of attention.

In-depth interviews

This format is also known as "one-on-one interviews". It is an effective way for moving to deeper layers of the customer's value perception.

All methods have their advantages and disadvantages. Focus groups and in-depth interviews can be compared because they both are interviewing techniques. Focus groups save time and stimulate group discussion while in-depth interviews allow for more detailed experience sharing. Furthermore, there is considerable training needed for the moderator in the case of focus groups, while interviewing techniques for in-depth interviews are more easily trained and learned. Observational techniques are more suitable for products than services, since it allows for actually observing the use or consumption, and watch the reactions of individuals as they use the product.

3.3 Conclusion

In this section we decide which attributes and elements we use in our value model.

For the graphical representation of the value model we use Woodall's representation approach. Like his model we show both attributes and outcomes. We do not include price in our model as explained before, although Woodall does this.

We use Anderson's Value Word Equations, because that provides a good structure to translate our attributes into outcomes.

For the case studies we use Gardial's in-dept-interview technique. This is the most appropriate method for this research since we visit the customer sites.


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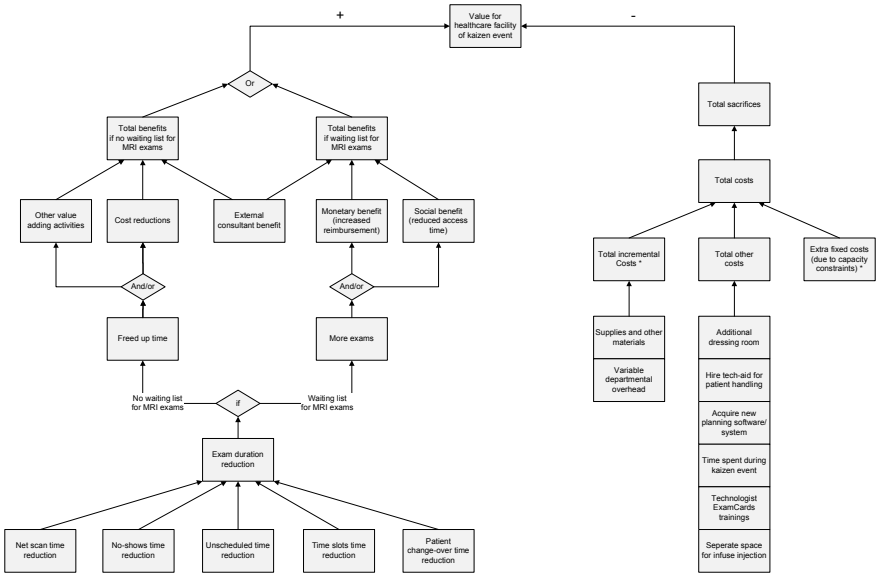
Part II: Value Model

From the different value framework perspectives in the literature,
we make one value model for this research.

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Chapter 4

Towards a Value Model for this Research

With the value model, we intend to explain how value is created and what the benefits are of a Kaizen Event. This means we need to know where and how in the MRI process value is realized with a Kaizen Event. We do this by first mapping the MRI scanning process (4.1), showing time wasters and critical processes within the MRI scanning process (4.2) and explaining what the Philips consultants currently do with a Kaizen Event (4.3). Then we find out how Philips can measure the current performance of the critical processes by presenting the data that Philips has available (4.4). We conclude this chapter by presenting the value model by explaining how value is created (4.5) and what the benefits are (4.6).

4.1 Mapping the MRI scanning process

A general process for imaging has already been mapped by Philips, by displaying the sequential steps in the process. The chain is for all imaging systems, like MRI, CT and Ultrasound. See Figure 4.1.

To understand in detail which activities are performed and by whom during the imaging process, we mapped the workflows at Catharina Hospital in Eindhoven and created a more detailed representation of the process. The used technique is loosely based on Business Process Modelling Notation (White, 2004). See Appendix C, where the process is split up into two processes. The first illustrates the steps from "receiving the order" to "scheduling the exam". The second from "confirming the exam" to "delivering the report". These are the same steps as in Figure 4.1.

4.2 Critical processes within the MRI scanning process

The general imaging process in Figure 4.1 shows five critical times. For the first four, Philips identified possible time wasters and critical processes, see Table 4.1 to Table 4.4.


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4.3 The Kaizen Event

As explained in the chapter 1, the Kaizen Event helps the healthcare facility reducing examination durations. In this section we elaborate more on the Kaizen Event so the reader can get a good understanding of the Kaizen Event.

4.3.1 What is the Kaizen Event?

The Kaizen Event is a one week event at the customer site. The goal is increasing the utilization of the MRI scanner. The Philips consultants do this by finding inefficiencies in the total scanning process and implementing improvements. During the event several meetings with the healthcare facility's staff take place.

4.3.2 Kaizen Event recommendations

Section 4.2 left us with time wasters and critical process within the MRI scanning process. Philips tackles these time wasters with the Kaizen Event. In this section we explain what recommendations the Philips consultants can give to healthcare facilities. Philips splits up the suggested improvements into two areas of improvement:

- *Optimizing scan protocols*
  Focuses on actual scanning of the MRI scanner
- *Optimizing workflows*
  Focuses on activities surrounding actual scanning

The general recommendations, and how they should be implemented, are shown in Table 4.5 and Table 4.6.

4.3.3 Kaizen Event in the imaging process activity chain

We stated in the introduction of this research that Kaizen Events focus on reducing examination duration. Exam duration[d] is defined as start of the first scan of patient 1 until the start of the first scan of patient 2. Now it is interesting to see how exam duration fits in the activity chain presented in Figure 4.1. The healthcare facility is interested in reducing exam duration, while patients are interested in reducing

[d] We sometimes use “exam duration” in short to describe “examination duration”

waiting times (besides quality of care). For this reason we reconstruct the activity chain from Figure 1 so that it represents the healthcare facility's view (top) and the patient's view (bottom). This provides the reader with a clear picture of all the relevant times related to the MRI activity chain. See Figure 4.2.

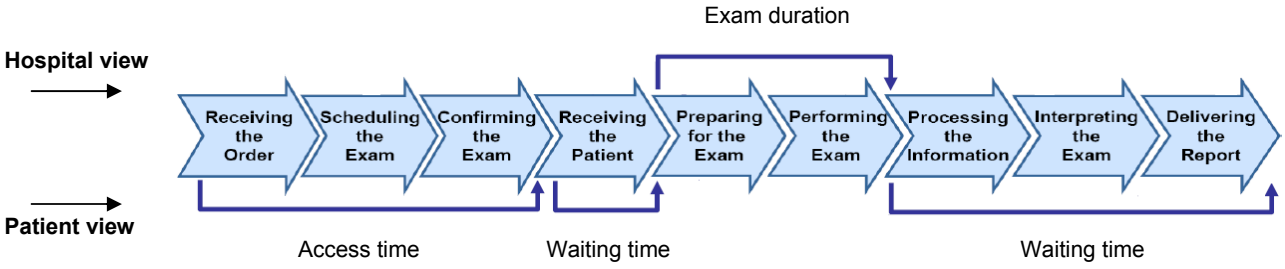

Figure 4.2 Imaging process (with hospital view and patient view)

It may be confusing for the reader that "preparation for the exam" is included in exam duration, since we stated that exam duration starts with the first scan of patient 1. However, the preparation of patient 2 is included in the exam duration. As we see later in this chapter, these two steps are not always sequential; they may overlap.

4.3.4 The Kaizen Event placed in Van Houdenhoven's framework

Van Houdenhoven (2007) developed a framework for hospital planning. This framework places different hospital activities in a matrix that identifies the managerial area and hierarchical decision level regarding the activities. The

hierarchical decomposition is strategic, tactical, operational offline and operational online. The difference between operational offline and online is that emergencies fall in the online category. The managerial areas are medical planning, resource capacity planning, material coordination and financial planning.

The Kaizen Event focuses on activities on the operational level, and take into consideration both offline and online planning. Regarding the managerial area, we can put the Kaizen Event in the resource capacity planning area. See Figure 4.3

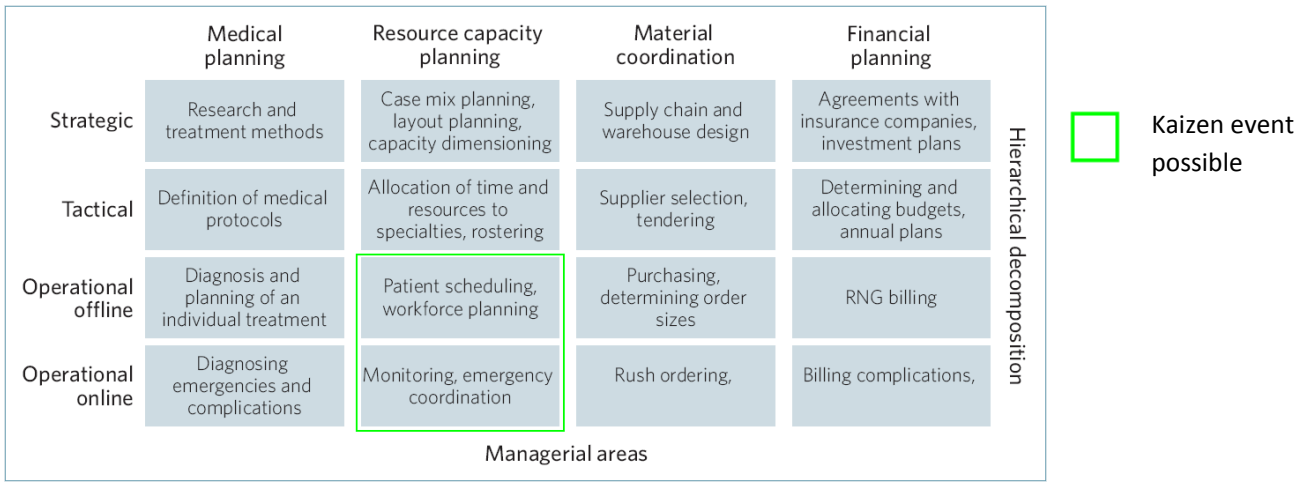

Figure 4.3: Framework for hospital planning and control (Van Houdenhoven, 2007)

4.4 What data does Philips have?

Philips can remotely detect actions performed on the MRI scanner. This allows Philips to see *what* exams are performed, *when* they are performed and *how long* it takes to finish exams. As a result, Philips can generate several reports regarding usage of the scanner. We display the most used reports on the next pages.


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We explain Figure 4.4 by the different colors used. An exam duration is from start light blue to the start of next light blue. Sometimes the light blue area is so small that it is hardly visible. Still, it is always there and comes after a dark grey area. The dark grey area indicates that the MRI scanner is waiting for the next patient to be entered in the system. To illustrate, the first exam on the day in Figure 4.4 starts at 08:05h and ends at 08:15h. The MRI scanner is 40 minutes idle between 15:15h and 15:55h. The day ends at 17:35h.

The reports displayed in Figure 4.5 and 4.6 show which exams are performed, of each exam how many are performed in a specified time period, and the average exam duration. Figure 4.5 also displays the preparation time and scan time.

This report shows the name, start time, end time and duration of the different protocols within one exam. Some explanation is needed here. The first column displays “Examcard name”. An Examcard is a set of protocols that together determine the output of one exam. A protocol is a set of images from one position/angle to the body. This report gives insight in the amount of protocols per exam.

This report shows the average exam duration over time.

Key Performance Indicators (KPIs)

For assessing the performance of the MRI scanner, Philips uses KPI reports. The KPIs are:

- Average number of exams per day
- Average examination duration
- Average scan time per examination
- Average scan ration
- Total duration per day


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Table 4.7 shows an example of such a KPI summary for an imaging center in Florida, United States of America, where a Kaizen Event was conducted in September 2008.

As can be seen, Southern Open MRI is performing better than the average, based on exam duration, but worse than the best practice. This overview provides quick information of how the facility performs compared to his peers and provides a rough estimate of how much room for improvement there is.

4.5 How value is created with a Kaizen Event

In this section we meet part of our research objective. We formulated the objective as:

"To craft a value model for Kaizen Events for the MRI scanning process in healthcare facilities that explains *how value is created* and *what the benefits are*".

This section explains how value is created with a Kaizen Event, while the next section explains what the benefits are of a Kaizen Event.

4.5.1 Exam duration components

At this point it is clear that the scope of the value model is exam duration reduction. If we want to understand exam duration reduction we have to define exam duration, otherwise we do not know what we are reducing. Next we identify all time components of exam duration.

To start with, exam duration can be split-up into two basic sequential steps: gross scan time and change-over time (C.O. time).

Gross scan time is the time from the instant the MRI scanner starts making scans (images) until the moment the MRI scanner makes the last scan for one patient. Change-over time is defined as the end of gross scan time for patient 1 until the start of gross scan time of patient 2. See Figure 4.9.

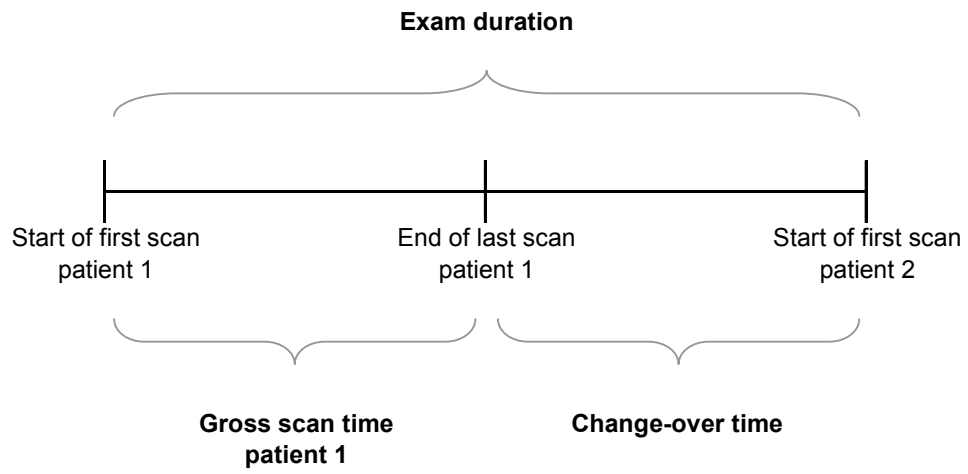

Figure 4.9: Exam duration (general)

To give the reader an idea how change-over time is distributed, we show 362 change-over observations of "Universitair Ziekenhuis Brussel" (April 2009) in Figure 4.10. All distribution graphs plotted in this report come from Minitab® software.

The next step is taking a magnifying glass and break down gross scan time and change-over time further, into lower level “times”. We start with gross scan time. Then we find out of what time components change-over time is built up.

Gross scan time

Gross scan time always consists of two different “times”:

- Net scan time
- In-between-protocol time

Net scan time is the time the MRI scanner is taking images during an exam. In-between-protocol time is the time when the scanner’s settings are adjusted within the net scan time. Images are made according different protocols, hence the name in-between-protocol time.

Change-over time

The idea of change-over time, as it was defined by Philips, is to show how long it takes a healthcare facility to change over patients on the MRI scanner. But when taking a glance at Figure 4.10, one can imagine that changing over a patient should not take 30 or 40 minutes (not to mention 109 minutes, which is the maximum). It appears there is more to change-over time than just changing patients. Change-over time is only equal to changing patients when the next patient is sitting in the waiting room. We call this particular time component of change-over time “patient-change-over time” (P.C.O. time). When there is no patient in the waiting room, there must be a reason for it (assuming there is a waiting list for getting an MRI scan). We find that this can have five reasons, and thus six (including patient-change-over time) different “times” can be part of change-over time. The six times are:

- Patient-change-over time
- No-shows time

- Unscheduled time
- Unused time slots time
- Scanner down time
- Preparation time

Next we define all these time components of change-over time:

- Patient-change-over time — the time it takes to change over two patients on the MRI scanner when the second patient is in the waiting room
- No-shows time: — the time the MRI scanner is not in use because a patient does not show up or is late
- Unscheduled time: — the time the MRI scanner is not in use because there is no patient scheduled in the period
- Unused time slots time: — the time the MRI scanner is not in use because the time slot reserved for a particular exam exceeds actual exam duration
- Scanner down time: — the time the MRI scanner in unavailable due to malfunctions
- Preparation time: — the time between entering patient 2 in the RIS (Radiology Information System) and start making scans

If we put the lower level times of gross scan time and change-over time in Figure 4.9, we get the detailed representation of exam duration. See Figure 4.11.

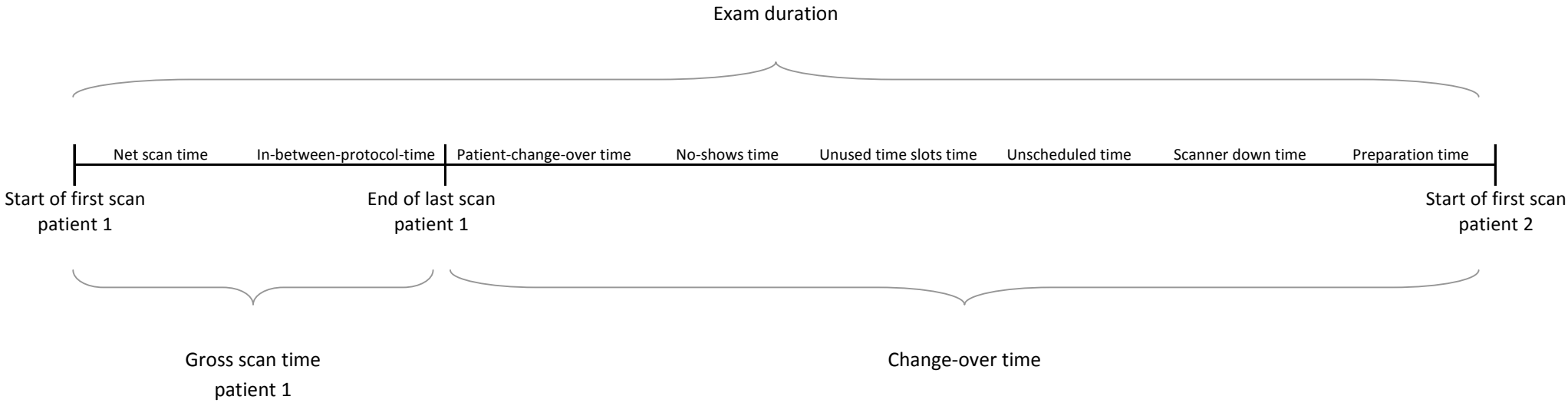

Figure 4.11: Examination duration (detailed)

4.5.2 Value Word Equations

To compute reductions in the exam duration time components as defined in the previous section, we construct Value Word Equations (Anderson, Kumar and Narus, 2007). These equations allow us to conceptualize the time savings in a structured way. There are in total eight different times in Figure 4.11, but there are five VWEs. This is because the Kaizen Event can not reduce all time components of exam duration. We explain this in more detail in section 4.6. See Figure 4.12 for the VWEs.

	Benefit	*Value Word Equation*	*Time savings (mins)*
VWE 1	Net scan time reduction (mins)	current net scan time – net scan time of top 10 performer	
VWE 2	No-shows time reduction (mins)	if { no-shows is between 5%-10% → [(current no-shows-% - 5%) X current examination duration]; no-shows is >10% → [(current no-shows-% - 10%) X current examination duration]	
VWE 3	Unused time slots time reduction (mins)	$\Sigma(i) = \frac{[\text{ current scheduled time for exam i } - \text{ (gross scan time exam i} + \text{patientchangeover time exam i)]}}{\text{i}}$	
VWE 4	Unscheduled time reduction (mins)	$\frac{\text{currentunscheduled timeperday} - 15\text{mins}}{\text{currentaverage\# examsperday}}$	
VWE 5	Patient-change-over time reduction (mins)	½σ of current average patient-change-over time	

Figure 4.12: Value Word Equations

Explanation of Value Word Equations

VWE 1: Net scan time reduction:

In VWE 1 we state that the net scan time of a healthcare facility can be decreased to the level of the top 10 performer. That is, if it is not an academic hospital. If the object under consideration is an academic hospital we can not reduce net scan time. Next we explain why we choose for the "top 10"- target and why we distinguish between the two categories.

We start our argument with a discussion on net scan time. Net scan time is determined by the Examcard that is used. An Examcard consists of a set of protocols. A protocol is a set of scans taken from a certain angle. We noticed that many radiologist use different protocols to come to the same end result, which is a diagnosis. Net scan time can be seen as a cooking recipe: different people have different ways of making lasagne. One can use different ingredients, more or less layers of meat, or longer or shorter baking time in the oven. This is more or less the same for Examcards. One can take scans from different angles, more or less protocols, or longer or shorter scans.

The end goal of net scanning differs among two types of healthcare facilities:

- Academic hospitals
- Non-academic hospitals and other MRI healthcare facilities

For academic hospitals the end result of an exam is not just the diagnosis. The radiologists do research on diseases, make the best scans as possible to present at congresses, and train students. For this reason, we cannot advise academic hospitals to revise their way of scanning and thus cannot reduce their net scan time.

For non-academic and other MRI healthcare facilities however, these extra activities are not relevant. The main reason why radiologists at these healthcare facilities have different Examcards is because they have been trained differently. Philips application

specialists can train radiologists at these healthcare facilities to implement more efficient Examcards. As a reference for target improvement we use the MRI facility in Kapfenberg, where dr. Sulzer works with very efficient Examcards. According to dr. Sulzer, his Examcards for knee, ankle and spine can be adopted by other healthcare facilities. For brain and abdomen, Examcard adoption is possible, but can depend more on individual preference and therefore we leave it out of the Value Word Equation. Since the Kapfenberg institute is among the top 10 of the performers worldwide, we use "top 10 performer" for sake of generalization. Next we present the net scan times of the top 10 performer, which can be adopted by other non-academic healthcare facilities:

Anatomy	*Net scan time*
Knee	10:30 mins[e]
Ankle	10:45 mins
Spine (lumbar spine)	11:00 mins
Spine (cervical spine)	9:45 mins

Table 4.13: Net scan time of "top 10 performer"

VWE 2: No-shows time reduction:

Philips can reduce the number of no-shows to 5% for a healthcare facility if the current number of no-shows is higher than 5%. If the number of no-shows is higher than 10%, Philips can reduce the number of no-shows to 10%. The 5% and 10% goals are chosen based on Philips Kaizen consultants' experiences.

[e] With x:y mins/minutes we mean x minutes and y seconds

But how does a reduction in no-shows affect exam duration? An exam consists of gross scan time and change-over time. A patient that does not show up results in a long change-over time. More no-shows thus results in a higher average change-over time and thus in a higher exam duration.

VWE 3: Unused time slots time reduction:

The third and fourth Value Word Equations are related to the planning system of the healthcare facility.

A time slot is the amount of time that is reserved for a particular type of exam, for example 20 minutes for a brain exam. If this reserved time is too high, it can happen that the next patient is not yet in the waiting room when an exam is finished, which means the MRI scanner is unnecessarily idle.

With a Kaizen Event we advise the healthcare facility to base the time slot on actual exam duration since we have that information. But if we recommend using the current exam duration, we still take a too large time slot, because we reduce exam duration with a Kaizen Event. For a time slot, the healthcare facility should reserve the new gross scan time plus the new patient-change-over time. The new gross scan time we can determine from VWE 1. As we will see in the explanation of VWE 5, the new change-over time should be equal to patient-change-over time if we remove all inefficiencies from change-over time. In reality there will always be some inefficiencies in change-over time, so change-over time will always be (slightly) higher than patient-change-over time. However, since we want to maximally utilize the MRI scanner we still take new gross scan time plus new patient-change-over time even if this sometimes means the patient has to wait a little longer in the waiting room.

VWE 4: Unscheduled time reduction:

If a healthcare facility does not schedule all operational time available, it is wasting time. This Value Word Equation relates to this wasted time. Depending on the planning system the healthcare facility uses, there can be more or less unscheduled time in the schedule. So we investigate how much time on average is not scheduled. We subtract 15 minutes in the equation from this unscheduled time, because we assume we cannot expect a perfectly efficient planning system and therefore zero unscheduled time.

VWE 5: Patient-change-over time reduction:

The average patient-change-over time can be reduced by ½σ. The "½σ reduction" is an estimation based on the Philips Kaizen consultants' experiences. This provides an internal benchmark, based on the variation of the hospital's own patient-change-over process. This means that a hospital with a higher variation can benefit more than hospitals with already a stable patient-change-over process.

Unfortunately, patient-change-over times cannot be retrieved directly from the Philips NetForum database. However, we can retrieve change-over times. We managed to transform change-over data so that it makes sense we are left with patient-change-over. We demonstrate this next.

To illustrate, we present the same change-over distribution as in Figure 4.10, from UZ Brussel, in Figure 4.13.

Philips made change-over data available with the intentions to represent patient-change-over. However, as we saw in section 4.5.1, change-over time consists of five other times, recall Figure 4.11. These other five time components are inefficiencies in change-over time, and are responsible for high change-over values. Because these other time components are inefficiencies and therefore not representative data for what we intend to measure, we consider these data to be outliers. If we remove all outliers from the change-over time distribution, we should be left with only the patient-change-over times.

The outlier analysis we perform is the Inter-Quartile-Range (IQR) analysis. This means we define the values Q1-(3*IQR) and Q3+(3*IQR) as outliers, where Q1 is the first quartile, Q3 is the third quartile, and IQR is the range between the first and the third quartile.

From Figure 4.12 we see that the IQR is 5.700, which means that all data with larger values than 10.712+(3*5.700) are considered outliers, and thus not representative data for patient-change-over time. For UZ Brussel, we present the patient-change-over distribution in Figure 4.14.

We can reduce the average patient-change-over time by ½σ. We graphically display this in Figure 4.15. The blue line indicates the current mean (8 minutes and 10 seconds). The green line indicates the patient-change-over goal, which is the new average P.C.O. time (5 minutes and 45 seconds). The potential time savings are thus 2 minutes and 25 seconds.

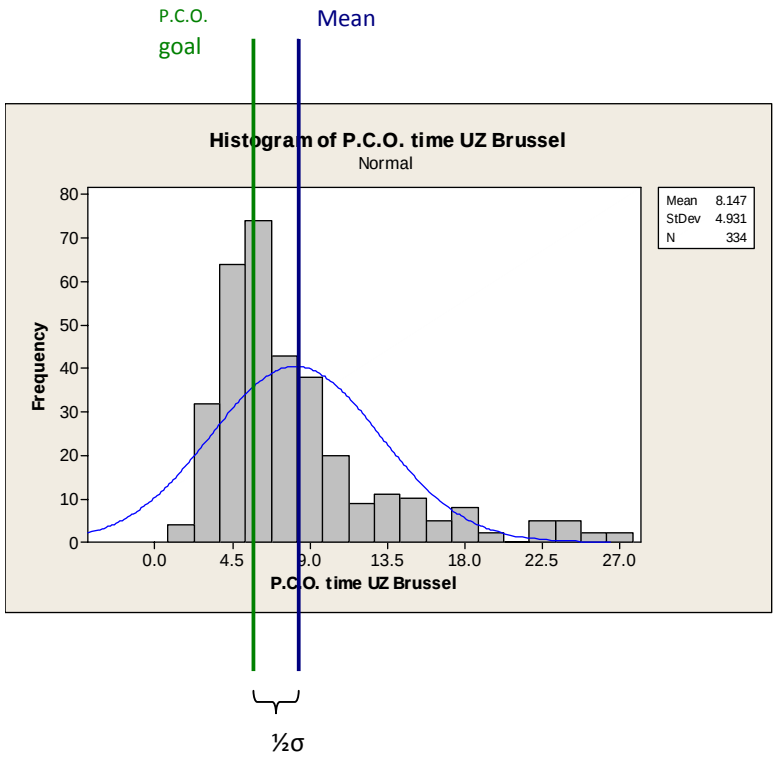

Figure 4.15: Patient-change-over goal (new mean)

4.6 What the benefits are of a Kaizen Event

In this section we meet the second part of our research objective, which is explaining what the benefits are of a Kaizen Event. We do this by presenting a graphical representation of the value model, see Figure 4.16. The model should be read bottom-up.

On the left side of the model the benefits are shown. On the bottom we see five different time reductions. These times are the same times as defined in Figure 4.11, which are time components of exam duration. However, in Figure 4.11 there are in total eight different time components, while Figure 4.16 shows five different time reductions. These five time components are the same as in the Value Word Equations (Figure 4.12). We now present which three time components are missing in the value model and why they are left out:

- Preparation time: This is a time component of change-over time. Preparation time is completely dependent on the administrative task of entering patient 2 in the software system. This can be done immediately after patient 1 leaves the MRI scanner, or somewhat later in the change-over process. The other five time components of change-over time overlap with the preparation time. Only a small portion of preparation time, is not overlapping with the other change-over components. This small portion consists of some clicks in the software system right before gross scan time of patient 2 starts. The non-overlapping part cannot be reduced by a Kaizen Event and is left out of the value model. Needless to say, the overlapping part is captured by the other time components of change-over time.
- Scanner down time: This is not reduced with a Kaizen Event.
- In-between-protocol time: This is not reduced with a Kaizen Event.

Then if we go one layer up in the Figure 4.16, we see that one of two situations is applicable for the healthcare facility: (1) there is a waiting list for MRI exams, or (2) there is no waiting list for MRI exams. Now we explain the resulting benefits for both situations.

(1) There is a waiting list for MRI exams:

This situation results in more MRI exams since demand is higher than capacity. More MRI exams result always in a social benefit and sometimes in a monetary benefit. A separate benefit of the Kaizen Event is the external consultant benefit.

The social benefit is reduced access time[f] for the patient.

The monetary benefit is an increased reimbursement due to the extra exams. If there is a monetary benefit or not depends on the reimbursement system of the country where the healthcare facility is located.

The third benefit in Figure 4.16 is the so called external consultant benefit. External advisors are perceived as more objective and more credible than internal advisors (IDCR, 2004). This will result in an easier change and implementation process. For this reason we consider this a benefit that can be communicated to the customer.

(2) There is no waiting list for MRI exams:

This situation results in freed up time since demand is lower than capacity. But how does freed up time benefit the healthcare facility? It can benefit in two different ways.

First, it can lead to other value adding activities. Graham (2000), states that anything we do that improves our use of time will benefit us. Employees will almost immediately benefit because the hours freed up will be shifted to activities that have value.

[f] We define access time to be the time between patient requesting an MRI exam and patient arriving at the healthcare facility to get the MRI exam

Second, if no opportunities for value adding activities arise, then cost reductions can be realized by cutting in personnel hours.

Next to the exam duration reduction benefits, in this situation there is also the external consultant benefit, for the same arguments as in the first situation.

On the right side of the model the sacrifices are shown. Sacrifices are all "downsides" of the Kaizen Event. The idea is of course that the benefits outweigh the sacrifices. In our case the sacrifices can all be put in costs. We define three types of sacrifices:

- Incremental costs — These are variable costs that increase with extra exams. This input comes from the cost model (Kuwornu, 2009), which is developed parallel to the value model.
- Extra fixed costs (due to capacity constraints) — This is the case when current fixed costs are not sufficient for the extra workload. This input comes from the cost model (Kuwornu, 2009), which is developed parallel to the value model.
- Other costs — These are costs that are incurred in order to successfully implement the recommendations of a Kaizen Event.

As explained, the incremental cost calculations and extra fixed cost calculations come from the cost model (Kuwornu, 2009). The other costs depend on the current state of the MRI scanning process of the hospital, and have to be calculated separately for each healthcare facility. We explain these costs in more detail next:

- Additional dressing room — There are two dressing rooms per MRI scanner needed to prevent this to be a bottleneck.

• Hire tech-aid for patient handling	There are two technologists needed per MRI scanner, or three technologists in case there are 2 MRI scanners in the process. If this criterion is not met, we advise hiring a tech-aid for patient handling.
• Acquire new planning software/system	When there are improvements necessary in the current planning system, cost have to be incurred for acquiring new software, or, if this is not possible, cost have to be incurred for implementing a new planning system in the current software.
• Time spent during Kaizen Event	Hospital personnel spends time during a Kaizen event. Most of that time is spent in such a way that it does not affect the personnel's regular work activities. However, sometimes it is necessary to spend extra time. A general rule of thumb is that this extra time is: manager 0.5 day, radiologist 0.5 day, technologist 1 day, planner 0.5 day.
• Technologists Examcards	To achieve a continuous improvement in net scan time, technologists should be trained for five days a year by Philips application specialists if net scan time reduction is possible.
• Separate space for infuse injection	If regulatory issues do not allow this to be done in the dressing room.

Not all listed costs shown in Figure 4.16 are always applicable for a specific healthcare facility. For each Kaizen Event there has to be investigated which costs will be incurred.

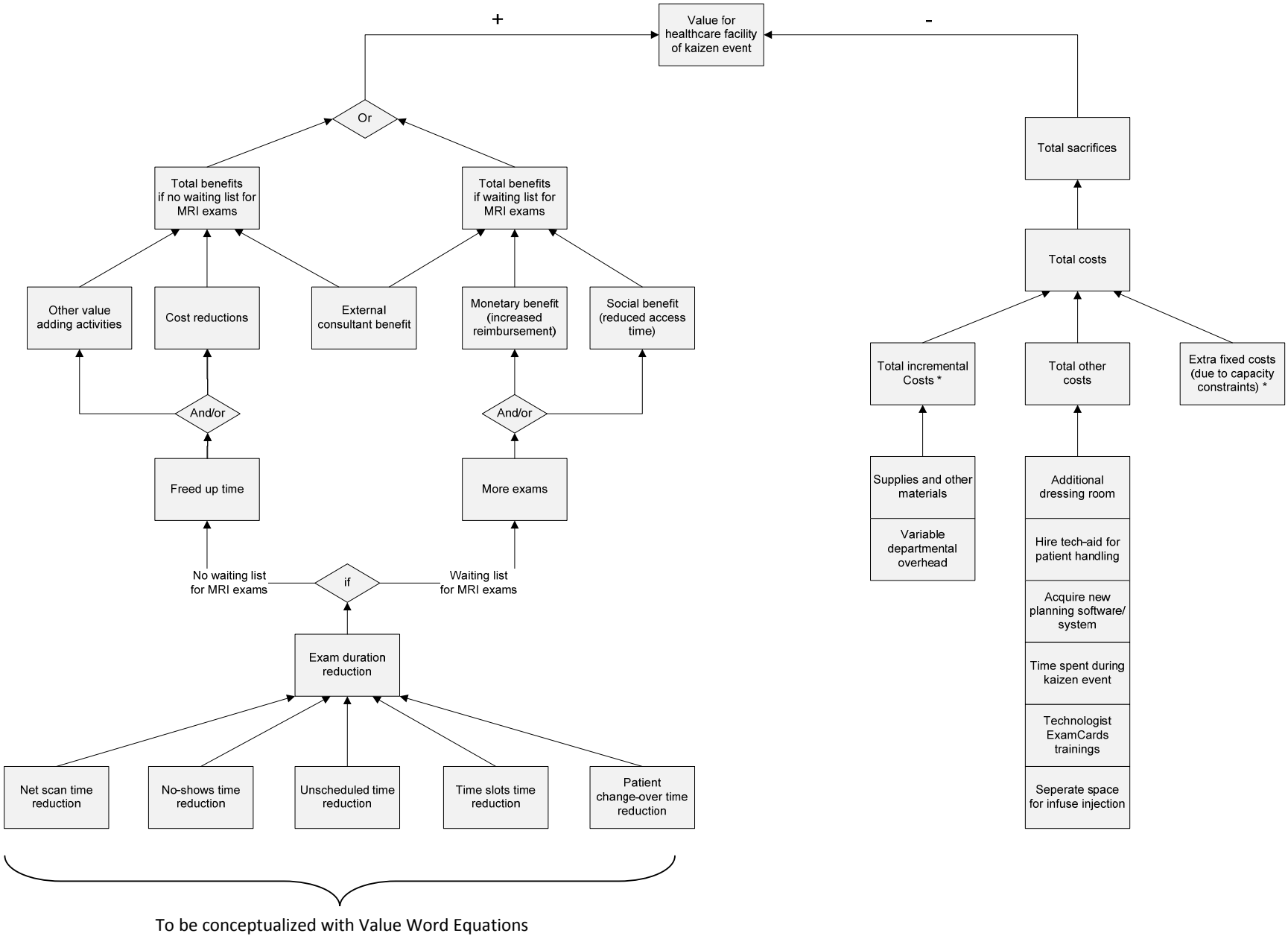

Figure 4.16: Graphical representation of the value model

* Input comes from the cost model (Kuwornu, 2009)

The + and – in the model indicate that the value for the hospital can be calculated by subtracting the sacrifices from the benefits.

4.7 Conclusion

The value model is the combination of sections 4.5 and 4.6. The objective was stated as:

"To craft a value model for Kaizen Events for the MRI scanning process in healthcare facilities that explains *how value is created* and *what the benefits are*".

In section 4.5 we explained how value is created with a Kaizen Event, by developing Value Word Equations which conceptualize time savings in a structured way. Section 4.6 showed what the benefits are of a Kaizen Event with the graphical representation of the value model.

To summarize, the value model for Kaizen Events is presented in this research by:
(1) The Value Word Equations, to explain how value is created.
(2) The graphical representation of the value model, to explain what the benefits are.


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Part III: Case Studies

Part three describes how the case study is performed and shows the results.
The results are used for showing the usefulness of the value model in practice.


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Chapter 5

Case Studies

We conduct four case studies to show the usefulness of the value model in practice. The incremental cost data and extra costs due to capacity constraints data come from the cost model (Kuwornu, 2009). We present the summarized value propositions for the healthcare facilities in this chapter. For detailed calculations regarding the VWEs we refer to the appendices E, F and G. For the complete value proposition reports we refer to appendices H, I and J.

5.1 Goal of the case studies

The goal of conducting case studies is finding out how well the proposed value model fulfils its purpose: explaining the value of a Kaizen Event to the healthcare facility. The case studies consist of collecting primary data. The resulting value propositions were sent to the case study objects and we present the collected feedback at the end of each section.

5.2 Case study objects

We perform four case studies at the following healthcare facilities:

- Ziekenhuis Rijnstate, *The Netherlands*
- Universitair Ziekenhuis Brussel, *Belgium*
- Institut für Radiologie Kapfenberg, *Austria*
- Krankenhuis der Barmherzigen Brüder, *Germany*

Ziekenhuis Rijnstate is a non-academic general hospital. Universitair Ziekenhuis Brussel and Krankenhaus der Barmherzigen Brüder are academic hospitals. Institut für Radiologie Kapfenberg is a private imaging centre.

We choose different types of healthcare facilities to find out differences in value creation (different outcomes in VWEs). We choose different countries to find out how benefits differ. We expect to see time savings in different time components and different benefits from the Kaizen Event.

5.3 In-dept interview technique

The case studies consist of interviews with staff from different departments within the healthcare facility. The interviewees are:

- Radiologist
- Manager
- Planner/scheduler
- Technologist
- Finance/accounting employee

We use semi-structured interview technique. This means we work out a set of questions beforehand, but intend the interview to be conversational. We can change the order of questions or leave out questions that may appear redundant. The main job is to get the interviewee to talk freely and openly while making sure we get the in-dept information that we need. The set of questions that we use for the interview can be found in appendix D.

5.4 Results case study

In this section we present the results of the case studies. We provide just the summary here, for detailed calculations we refer to the appendices E, F and G.

5.4.1 Ziekenhuis Rijnstate, The Netherlands

How value is created

We present the outcome of the Value Word Equations in this section. The detailed calculations can be found in appendix E.

Value Word Equations	
Net scan time reduction	0:45 mins
No-shows time reduction	0:00 mins
Unused time slots time reduction	1:40 mins
Unscheduled time reduction	4:25 mins
Patient-change-over time reduction	2:20 mins
Total	**9:10 mins**

Table 5.1: Value Word Equations for ziekenhuis Rijnstate

Benefits

Since there is a waiting list for MRI exams, these time savings result in extra exams. Rijnstate currently conducts approximately 5,120[g] exams per MRI scanner per year. Next we calculate the new number of exams as a result of the exam duration reduction. Subtracting the current number of exams from the new number of exams leaves us with the extra exams.

Extra exams	
Operating minutes per day	600 mins
Operating days per year	240 days/year[h]
Current average exam duration	28:00 mins
Current number of exams per year	(600 x 240) / 28:00 mins = 5,120 exams/year
New number of exams per year	(600 x 240) / 18:50 mins = 7,646 exams/year
Number of extra exams per year	2,526 exams/year per MRI scanner

Table 5.2: Extra exams for ziekenhuis Rijnstate

There are two MRI scanners in the same hospital area, which means that both scanners benefit from the time savings equally. For that reason, the total number of extra exams per year will be (2,526 x 2 =) 5,052.

Sacrifices

Here we present all costs that Rijnstate will incur, not including the price of the Kaizen Event.

[g] Information retrieved from NetForum database

[h] This number is the only unknown variable and is retrieved that way

Incremental costs	
Extra exams per year	5,052 exams/year
Incremental costs per exam	€ 17.04 (Kuwornu, 2009, pg. 79)
Yearly incremental costs	**5,052 x € 17.04 = € 86,086.-**

Table 5.3: Incremental costs for ziekenhuis Rijnstate

Extra fixed costs due to capacity constraints	
1 extra radiologist (yearly salary)	€ 200,000.-[i]

Table 5.4: Extra fixed costs due to capacity constraints for ziekenhuis Rijnstate

Other costs	
New planning system	€ 1,000.-
Time spent during Kaizen Event	€ 1,625.-
Technologists trainings Examcards	€ 3,500.-
Total other costs	**€ 6,125.-**

Table 5.5: Other costs for ziekenhuis Rijnstate

Value proposition

The value proposition is the total of benefits minus sacrifices. It appears that the Dutch reimbursement system does not reward hospitals directly for extra exams in monetary terms. The main causes are the DBC system (Diagnose Behandeling

[i] Average salary of self-employed radiologist (http://www.gobnet.nl/beroep.php?id=105&p=5)

Combinatie) and the complex organizational structure of hospitals. The DBC system grants a yearly fixed amount for MRI exams, which means that extra exams are not directly reimbursed. However, if the hospital can show that in next years it will conduct more exams (for example because of the Kaizen Event), then it is possible to get a higher fixed amount in the next year for MRI exams. However, after interviews with managers from Rijnstate hospital (Arnhem) and Maxima hospital (Veldhoven), it appears that due to the complex organizational structure where radiologists are not employed by the hospital, the hospital does not profit from this increased yearly amount.

There is a social benefit, namely a reduced access time. The current average access time is 2-3 weeks. The number of exams is increased with 52%, which means the access time for patients to get an MRI exam will decrease.

The last benefit is the external consultant benefit. External advisors are perceived as more objective and more credible than internal advisors (IDCR, 2004). This will result in an easier change and implementation process.

Total sacrifices are € 292,211.-.

Feedback

We sent a value position report, which can be found in Appendix H, to ziekenhuis Rijnstate, to find out how convincing our method for measuring value is to customers. We had a telephone call with Mr. Twilhaar, manager of the radiology department, to gather the feedback. His main comments are:

- Reading the summary, he felt 5,052 extra MRI exams per year are overestimated. However, all five equations were convincing to him so that he feels the extra exams are realizable over time.
- The 45 seconds time savings with respect to the net scan time is possible.

- The average unscheduled time of 1 hour and 35 minutes is shocking and provides great insight for potential time savings.
- The external consultant benefit is indeed applicable because the experience an external consultant brings has impact.
- The monetary benefit regarding the DBC system is indeed still unclear. However, cost reductions per MRI exam as a result of increased utilization is already valuable information.

5.4.2 Universitair Ziekenhuis Brussel, Belgium

How value is created

We present the outcome of the Value Word Equations in this section. The detailed calculations can be found in appendix F.

Value Word Equations	
Net scan time reduction	0:00 mins
No-shows time reduction	0:00 mins
Unused time slots time reduction	4:30 mins
Unscheduled time reduction	0:45 mins
Patient-change-over time reduction	2:25 mins
Total	**7:40 mins**

Table 5.6: Value Word Equations for UZ Brussel

Benefits

Since there is a waiting list for MRI exams, these time savings result in extra exams. UZ Brussel currently conducts approximately 5,445[j] exams per MRI scanner per year. Next we calculate the new number of exams as a result of the exam duration reduction. Subtracting the current number of exams from the new number of exams leaves us with the extra exams.

[j] Information retrieved from UZ Brussel's internal documents

Extra exams	
Operating minutes per day	870 mins
Operating days per year	210 days/year[k]
Current average exam duration	33:30 mins
Current number of exams per year	(870 x 210) / 33:30 mins = 5,445 exams/year
New number of exams per year	(870 x 210) / 25:50 mins = 7,072 exams/year
Number of extra exams per year	1,627 exams/year per MRI scanner

Table 5.7: Extra exams for UZ Brussel

There are two MRI scanners in the same hospital area, which means that both scanners benefit from the time savings equally. For that reason, the total number of extra exams per year will be (1,627 x 2 =) 3,254.

Sacrifices

Here we present all costs that UZ Brussel will incur, not including the price of the Kaizen Event.

Incremental costs	
Extra exams per year	3,254 exams/year
Incremental costs per exam	€ 12.76 euro (Kuwornu, 2009, pg. 84)
Yearly incremental costs	**3,254 x € 12.76 = € 41,521.-**

Table 5.8: Incremental costs for UZ Brussel

[k] This number is the only unknown variable and is retrieved that way

Extra fixed costs due to capacity constraints	
1 extra radiologist (yearly salary)	€ 200,000 (Kuwornu, 2009, pg. 69)

Table 5.9: Extra fixed costs due to capacity constraints for UZ Brussel

Other costs	
New planning system:	€ 1,000.-
Time spent during Kaizen Event	€ 1,625.-
Total other costs	**€ 2,625.-**

Table 5.10: Other costs for UZ Brussel

Value proposition

We start with presenting the monetary benefit. The Belgium reimbursement system does provide healthcare facilities with revenues for extra exams. The reimbursement differs per type of exam. For the Pareto exams for UZ Brussel the reimbursements are:

Brain (33%): € 158.66
Spine (22%): € 158.66
Knee (14%): € 119.71

For the other exams the reimbursement is on average € 220.-. Now we can calculate the monetary benefit from the Kaizen Event:

Monetary benefit	
Average reimbursement for exam	(0.33 x € 158.66) + (0.22 x € 158.66) + (0.14 x € 119.71) + (0.31 x € 220.-) ≈ € 170.-
Extra number of exams per year	3,254 exams/year
Total monetary benefit	**3,254 x € 170.- = € 553,180.-**

Table 5.11: Monetary benefit for UZ Brussel

Next to the monetary benefit, there is a social benefit, namely of a reduced access time. The current average access time is 2-3 weeks. The number of exams is increased with 30%, which means the access time for patients to get an MRI exam will decrease.

The last benefit is the external consultant benefit. External advisors are perceived as more objective and more credible than internal advisors (IDCR, 2004). This will result in an easier change and implementation process.

Summarizing, the net (monetary) value for UZ Brussel is the total monetary benefit minus total sacrifices: € 553,180.- – € 244,146.- = **€ 309,034.-**

Feedback

We sent a value position report, which can be found in Appendix I, to UZ Brussel to find out how convincing our method for measuring value is to customers. We had a telephone call with prof. de Mey, manager of the radiology department, to gather the feedback. His main comments are:

- The patient-change-over time reduction is indeed possible.

- The results from the equations regarding the unused time slots and unscheduled time are interesting. However, he has doubts if the time savings are really possible. His main issues are the variability in exam times regarding the time slots which already results sometimes in high patient waiting times, and the emergency cases regarding unscheduled time, which he is not sure allows the planning system to be tighter.
- The reimbursement figures are approximately correct.
- Overall, the value proposition is very interesting.

5.4.3 Institut für Radiologie Kapfenberg, Austria

The case study in Austria is different from the other three case studies, because a Kaizen Event has already been done in March 2009. This means we do not use our model to conceptualize potential time savings, but we use real data to see realized improvements. Based on the given recommendations by the Kaizen consultants, we allocate the realized time savings back to the Value Word Equations as accurate a possible.

How value was created

The average exam duration before the Kaizen Event was 18:00 mins. There are four months of data available from after the Kaizen Event. The new average exam duration is 17:00 mins. That is an exam duration reduction of 1:00 mins. See Figure 5.1.

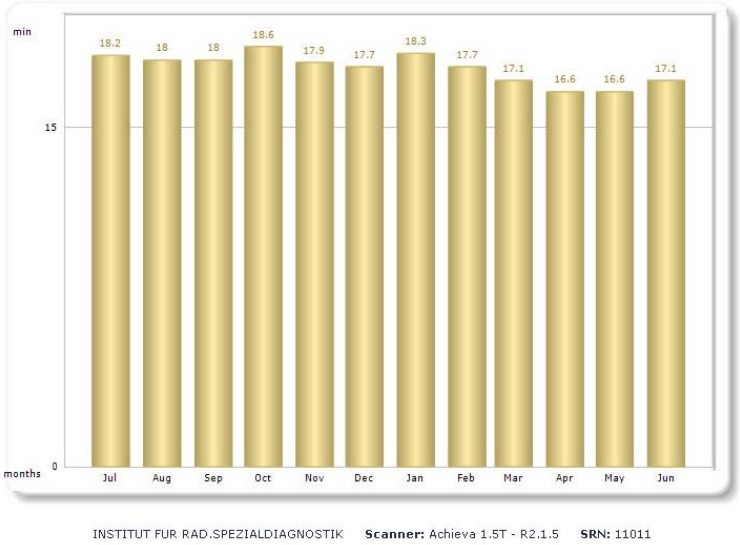

Figure 5.1: Average exam duration over time (July 2008 – June 2009)

Next we allocate the 1:00 minute back to the Value Word Equations, based on the given recommendations by the Kaizen consultants. The main recommendations were:

- *Reduce patient-change-over* by better technologist/technologist and technologist/radiologist collaboration
- *Reduce no-shows* by reminder calls for first three patients of the day

Both patient-change-over time and no-shows time are part of change-over time. Next we plot the change-over times before and after the Kaizen Event. Then we can filter patient-change-over times before and after the Kaizen Event with the IQR outlier analysis. This analysis allows us to find out how much patient-change-over time has been reduced, and also how much no-shows time has been reduced since that is the complement of total time savings.

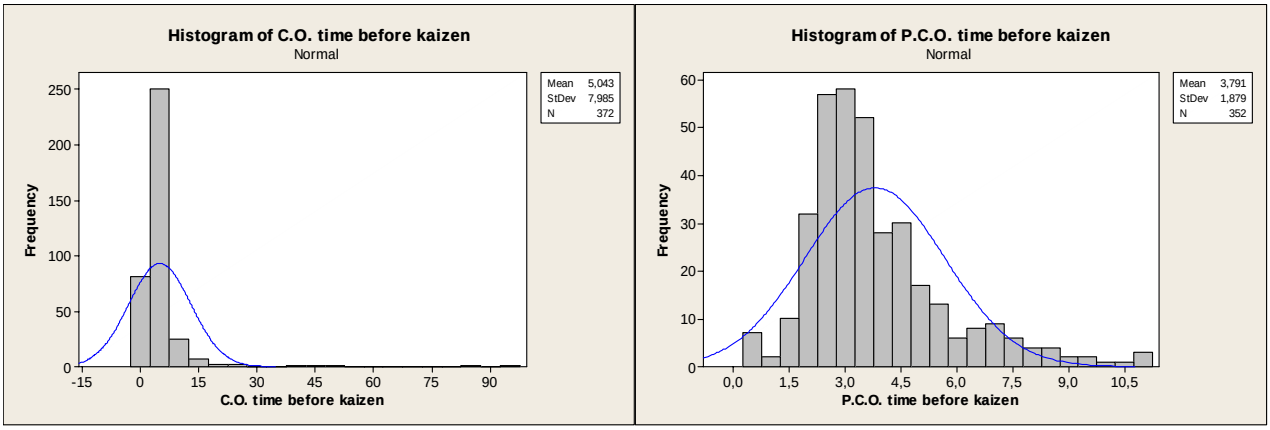

Figure 5.2: Change-over time and patient-change-over time before Kaizen Event

The left hand side of Figure 5.2 shows us that change-over time was 5:00 mins before the Kaizen Event. Removing the outliers leaves us with patient-change-over time, which was 3:50 mins before the Kaizen Event (right hand side Figure 5.2). Next we plot the change-over times and patient-change-over times from after the Kaizen Event.

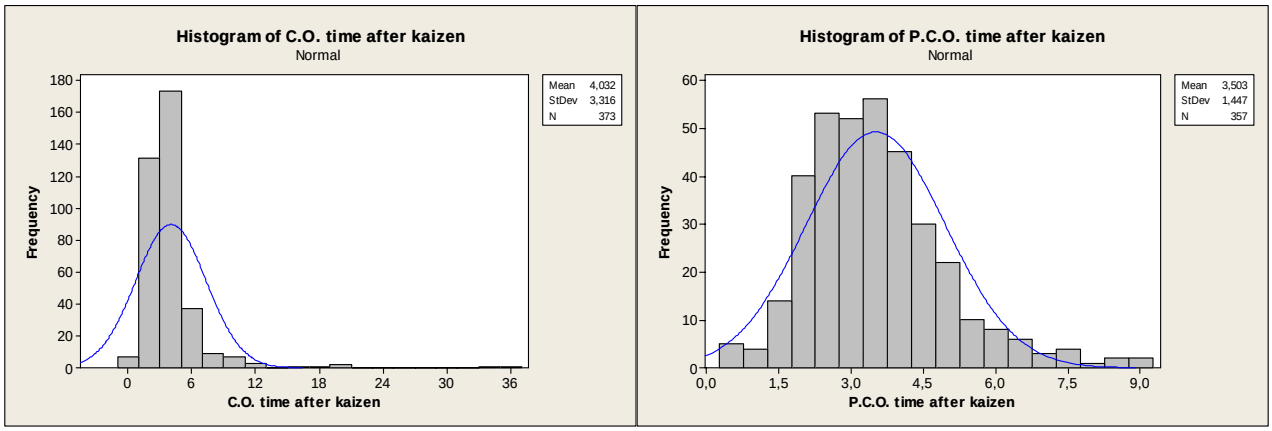

Figure 5.3: Change-over time and patient-change-over time after Kaizen Event

The left hand side of Figure 5.3 shows us that change-over time is 4:00 mins. This result is exactly as expected, since we saw in Figure 5.1 that total time savings are 1:00 minute and stated that this can in total be allocated to change-over time considering the recommendations given by the Kaizen consultants. Figure 5.3 also shows that patient-change-over time now is 3:30 mins. This analysis shows us that patient-change-over time has been reduced by 20 seconds. Total time savings are 1:00 minute, so the remaining 40 seconds time savings can be allocated to the other improvements, which in this case was no-shows reduction.

Although the Kaizen Event has already been done, we can still fill in the Value Word Equations. The only difference is that the actual time savings are known in stead of educated guesses. The Value Word Equations are:

Value Word Equations	
Net scan time reduction	0:00 mins
No-shows time reduction	0:40 mins
Unused time slots time reduction	0:00 mins
Unscheduled time reduction	0:00 mins
Patient-change-over time reduction	0:20 mins
Total	**1:00 mins**

Table 5.12: Value Word Equations for Institut für Radiologie Kapfenberg

Benefits

Since there is a waiting list for MRI exams, these time savings result in extra exams. Institut für Radiologie Kapfenberg previously conducted approximately 8,600 exams per year. Next we calculate the new number of exams as a result of the exam duration reduction. Subtracting the old number of exams from the new number of exams leaves us with the extra exams.

Extra exams	
Operating minutes per day	620 mins
Operating days per year	250 days/year
Old average exam duration	18:00 mins
Old number of exams per year	(620 x 250) / 18:00 mins = 8,600 exams/year
New number of exams per year	(620 x 250) / 17:00 mins = 9,105 exams/year
Number of extra exams per year	505 exams/year

Table 5.13: Extra exams for Institut für Radiologie Kapfenberg

That is 505 extra exams per year per MRI scanner. Since there is only one MRI scanner at the healthcare facility, this is the total number of extra exams per year.

Sacrifices

Here we present all costs that Institut für Radiologie Kapfenberg incurs, not including the price of the Kaizen Event.

Incremental costs	
Extra exams per year	505 exams/year
Incremental costs per exam	€ 18.47 (Kuwornu, 2009, pg. 89)
Yearly incremental costs	**505 x € 18.47 = € 9,327.-**

Table 5.14: Incremental costs for Institut für Radiologie Kapfenberg

There are no fixed costs due to capacity constraints: the yearly extra 505 exams can be conducted by the current staff of radiologists.

Other costs	
Time spent during Kaizen Event	€ 1,625.-

Table 5.15: Other costs for Institut für Radiologie Kapfenberg

Value proposition

We start with presenting the monetary benefit. The Austrian reimbursement system does provide healthcare facilities with revenues for extra exams. The reimbursement differs per type of exam. For the Pareto exams for Institut für Radiologie Kapfenberg the reimbursements are:

Knee (33%): € 50.-
Spine (18%): € 50.-
Brain (16%): € 70.-
Shoulder (10%): € 70.-

For the other exams the reimbursement is on average € 70.-. Now we can calculate the monetary benefit from the Kaizen Event:

Monetary benefit	
Average reimbursement for exam	(0.33 x € 50.-) + (0.18 x € 50.-) + (0.16 x € 70.-) + (0.10 x € 70.-) + (0.23 x € 70.-) ≈ € 60.-
Extra number of exams per year	505 exams/year
Total monetary benefit	**505 x € 60.- = € 30,300.-**

Table 5.16: Monetary benefit for Institut für Radiologie Kapfenberg

Next to the monetary benefit, there is a social benefit, namely a reduced access time. The current average access time is 1-2 weeks. The number of exams is increased with 6%, which means the access time for patients to get an MRI exam will decrease.

The last benefit is the external consultant benefit. External advisors are perceived as more objective and more credible than internal advisors (IDCR, 2004). This will result in an easier change and implementation process.

Summarizing, the net (monetary) value for Institut für Radiologie Kapfenberg is the total monetary benefit minus total sacrifices: € 30,300.- – € 10,952.- = **€ 19,348.-**

Feedback

We sent a value creation report, which can be found in Appendix J, to Institut für Radiologie Kapfenberg to find out how convincing our method for measuring value is to customers. We gathered feedback from dr. Sulzer, radiologist. His main comments are:

- The outlier analysis for conceptualizing patient-change-over time reduction makes sense.
- The 20 seconds reduction which is calculated for our facility is approximately accurate.
- The reimbursement figures for MRI exams are approximately accurate.

5.4.4 Krankenhaus der Barmherzigen Brüder, Germany

How value is created

We present the outcome of the Value Word Equations in this section. The detailed calculations can be found in appendix G.

Value Word Equations	
Net scan time reduction	0:00 mins
No-shows time reduction	0:00 mins
Unused time slots time reduction	2:10 mins
Unscheduled time reduction	0:00 mins
Patient-change-over time reduction	1:55 mins
Total	**4:05 mins**

Table 5.17: Value Word Equations for Krankenhaus der Barmherzigen Brüder

We were not able to calculate the VWEs regarding no-shows and unscheduled time, because we could not acquire the relevant information from the hospital.

Benefits

Since there is a waiting list for MRI exams, these time savings result in extra exams. Krankenhaus der Barmherzigen Brüder currently conducts approximately 3,900 exams per MRI scanner per year. Next we calculate the new number of exams as a result of the exam duration reduction. Subtracting the old number of exams from the new number of exams leaves us with the extra exams.

Extra exams	
Operating minutes per day	600 mins
Operating days per year	320 days/year[I]
Old average exam duration	49:30 mins
Old number of exams per year	(600 x 320) / 49:30 mins = 3,900 exams/year
New number of exams per year	(600 x 320) / 45:25 mins = 4,230 exams/year
Number of extra exams per year	330 exams/year

Table 5.18: Extra exams for Krankenhaus der Barmherzigen Brüder

There are two MRI scanners on different floors in the hospital, which does not necessarily mean that both scanners benefit from the time savings equally. We know the planning is done differently so the time savings with respect to unscheduled time can be different. Furthermore, both MRI scanners are in general managed differently. This could imply that the number of no-shows differ for both MRI scanners. However, the outcome of these VWEs are not in the 4:05 minutes time savings. The outcome of the two VWEs that are in the 4:05 minutes time savings can be generalized for both MRI scanners since the same time slots are used and we analyzed for both MRI scanners the P.C.O. times and took the average. For these reasons, the total number of extra exams per year will be (330 x 2 =) 660.

Sacrifices

Here we present all costs that Krankenhaus der Barmherzigen Brüder will incur, not including the price of the Kaizen Event.

[I] This number is the only unknown variable and is retrieved that way

Incremental costs	
Extra exams per year	660 exams/year
Incremental costs per exam	€ 37.47 euro (Kuwornu, 2009, pg. 94)
Yearly incremental costs	**660 x € 37.47 = € 24,730.-**

Table 5.19: Incremental costs for krankenhaus der Barmherzigen Brüder

We do not calculate the other costs of a Kaizen Event. The reason for this is that the cost components that we identified in "other costs" do not make sense since we do not recommend a Kaizen Event as improvement method. We recommend a more radical process improvement approach, which we elaborate on in section 6.2.1.

Value proposition

Since we do not recommend a Kaizen Event for Krankenhaus der Barmherzigen Brüder, our value proposition format is not the right way to inform the case study object. Because of time constraints we were not able to adjust our value proposition for a more radical approach and collect feedback.

Chapter 6

Conclusions and Recommendations

In this chapter we evaluate our research objective and give recommendations. First we give answers to the research questions and conclude how well our approach for measuring value works (6.1). Then we give recommendations regarding the Kaizen Event and suggestions for further research (6.2).

6.1 Conclusions

6.1.1 Answers to the research questions

In this section we come back to our research questions. We repeat the research questions one by one. We limit ourselves to presenting the answers to the main research questions here and not the sub questions. The sub questions helped us finding the answers to the main questions.

1. How should value be defined for Kaizen Events for the MRI scanning process?

Chapter 1 was our journey for finding the value definition for Kaizen Events for the MRI scanning process. The resulting value definition is:

"The value for a healthcare facility (Net VC) related to a Kaizen Event for the MRI scanning process is the difference between what is received (the worth), and what is given, expressed in monetary terms where possible, compared to the situation without a Kaizen Event (doing nothing)."

2. How should value be measured for Kaizen Events for the MRI scanning process?

For the graphical presentation of the value model we used Woodall's representation approach. Like his model we showed both attributes and outcomes. We did not include price in our model.

Also, we used Anderson's Value Word Equations for conceptualizing time savings, because that provides a good structure to translate our attributes into outcomes.

For the case studies we used Gardial's in-dept-interview technique. This is the most appropriate method for this research since we visited the customer sites.

3. What is the appropriate model for measuring value for Kaizen Events for the MRI scanning process?

The value model explains how value is created by delving into the deeper layers of exam duration and defining the lowest level time components within exam duration. The result is that exam duration consists of eight different time components. The time savings in the time components can be conceptualized with the Value Word Equations, see Figure 4.12. The Value Word Equations encompass five time components, because three of the time components are not reduced with a Kaizen Event. Next to explaining how value is created, the value model translates exam duration reduction into benefits for the healthcare facility. We identified a monetary benefit, social benefit and external consultant benefit in case there is a waiting list for MRI exams. We identified new value adding activities, cost reduction and external consultant benefit in case there is no waiting list for MRI exams.

The value model also accounts for the sacrifices to be made, which are the total costs to be incurred by the healthcare facility, except the price of the consult, to make the Kaizen Event to a success.

The benefits minus the sacrifices result in the value for the healthcare facility. The value model can be found in Figure 4.16.

4. How well does the value model explain how value is created and what the benefits are, and can the suggested method be used for a value proposition in practice?

The case study feedback shows that the Value Word Equations are easy to understand and convincing. During the research and case studies we did not encounter any Kaizen Event improvements/recommendations that can not be captured with one of the five Value Word Equations. In that sense we can conclude that the Value Word Equations succeed in explaining how value is created with a Kaizen Event.

Regarding the benefits, we conclude that the monetary benefit is the easiest to communicate to potential customers. If the reimbursement system of the relevant country is investigated, the monetary benefit can be calculated, given the extra number of exams as a result of the Kaizen Event. We validated the external consultant benefit by Rijnstate's feedback, who states that the experience of an external consultant has impact. We did not conceptualize access time reduction, which is the third benefit in case there is a waiting list for MRI exams. During the case studies, we did not encounter the situation of no waiting list for MRI exams, so we were not able to evaluate that situation's benefits.

The usefulness of the value model in practice depends on the accuracy of the Value Word Equations. We conclude that the outcome of the Value Word Equations is the maximum time savings possible with a Kaizen Event. This should carefully be communicated to the customer in order to manage the expectations well.

Furthermore, when evaluating the correctness of our Value Word Equations, we saw that two VWEs might not be completely accurate: the VWE regarding patient-change-over time reduction and the VWE regarding the no-shows time reduction.

During our Kapfenberg case study we saw that a 20 seconds P.C.O. time was realized. Before the Kaizen Event P.C.O. time was on average 3:50 minutes with σ=1:50 minutes. In our fifth VWE we state that P.C.O. time can be reduced by ½σ. However, 20 seconds is only ⅓σ. It could be that we overestimated the potential P.C.O. time reduction. What is also possible is that the potential P.C.O. time reduction increases with current mean P.C.O. time. This would explain why Kapfenberg only reduced P.C.O. time by ⅓σ, since they already had a low mean P.C.O. time (top 25 performer worldwide). For less efficient hospitals it could still be true that ½σ P.C.O. time reduction is realizable. We conclude that Philips should be careful in communicating ½σ P.C.O. time reduction. Next to the P.C.O. time VWE, we have doubts regarding the correctness of the no-shows VWE. There we state that hospitals with higher than 5% no-shows Philips can reduce that to 5%. However, during our case studies at Rijnstate and UZ Brussel, we found that hospital managements feels the number of no-shows can be reduced. But our VWE did not show higher than 5% no-shows in both cases. We conclude that it the 5% may be a too high estimate, and that for example no-shows can be reduced to 2% with a Kaizen Event. Philips should re-evaluate this target percentage.

Regarding the different types of healthcare facilities (academic, non-academic, private imaging center), we wanted to find out differences in how value is created. We saw that for the academic hospitals most value can be created with time slots reduction. For the non-academic hospital most value can be created with revising the planning system. For the private imaging center most value was created with improving the no-shows procedure. We can not conclude any significant differences based on our four case studies, but it is still interesting to see how the value creation possibilities differ.

Regarding the different countries (The Netherlands, Belgium, Austria, Germany), we intended to find out differences in benefits. We saw that Belgium and Austria do have a direct monetary benefit from extra MRI exams. For The Netherlands and Germany this monetary benefit is less clear because of the more complex DRG

system. In these cases, the social benefit of access time reduction is the most interesting.

6.1.2 Evaluation of the research objective

Our research objective was stated in the beginning of this research:

"To craft a value model for Kaizen Events for the MRI scanning process in healthcare facilities that explains how value is created and what the benefits are".

The research questions were our guideline in reaching the research objective. Section 6.1.1 showed that we were successful in finding answers to our research questions. It is thus only logical that we succeeded in meeting the research objective. We crafted a value model for Kaizen Events for the MRI scanning process in healthcare facilities. The model explains how value is created, see Figure 4.12 (Value Word Equations), and explains what the benefits are, see Figure 4.16 (graphical representation of the value model).

6.1.3 Limitations

During our case studies we did not account for the healthcare facility's internal KPIs regarding the planning system. For example, minimizing patient waiting time, maximizing utilization or minimizing overtime. If we know the healthcare facility's priorities, then we can already find a suitable planning system and more accurately estimate potential time savings regarding the more efficient new planning system.

The VWEs project the maximum achievable time savings for the current MRI scanning process for the healthcare facility. It could be that exam duration with higher variability need longer time slots than average gross scan time plus patient-change-over time. We did not account for this in our VWE. The consequence could be that less time savings are possible with the VWE regarding time slots.

In our value propositions we did not explain with what activities we exactly realize the time savings. Because of this, UZ Brussel has doubts regarding the achievability of the suggested time savings with respect to unscheduled time. The argument is that a planning system can not be as tight with many emergency cases. UZ Brussel does schedule time for emergency cases. The unscheduled time is used as a buffer for emergencies. In calculating the potential time savings we did not account for emergency buffers with respect to unscheduled time. However, our intentions were not to exactly describe with what activities we realize time savings. The value model does "only" explain how much time savings can be realized. The limitation here is that we did not explain if and how we handle emergency cases in the new planning system.

6.2 Recommendations

In this section we give several recommendations. We start with general Kaizen Event recommendations (6.2.1). Then we give recommendations on value-based pricing (6.2.2) and business models for Kaizen Events (6.2.3). We finalize this section with recommendations for further research (6.4.4).

6.2.1 General Kaizen Event recommendations

The Kaizen Events are currently in the pilot phase, which means they are not conducted at healthcare facilities on a well organized, large scale. As a result of this, we see possibilities for improvements on different areas. We formulate these recommendations next.

Organization

Kaizen Events are organized on an ad hoc, or reactive, basis. Healthcare facilities request the Kaizen Event after hearing about it via colleagues, after attending a radiology congress where Philips explains the Kaizen Event, or after reading a healthcare business magazine. We recommend approaching potential customers on a more proactive basis in the near future, because we feel Philips has a powerful service in its toolbox with the Kaizen Event. Philips can do this by finding healthcare facilities with high exam duration from NetForum and investigating the problems regarding productivity and placing the problems in Van Houdenhoven's matrix (see Figure 6.1). If a Kaizen Event then appears to be the appropriate improvement method, Philips can suggest a Kaizen Event.

Furthermore, there is no uniformity in how many times the Philips Kaizen consultants visit the customer site for one Kaizen Event. In most cases, a Kaizen Event consists of a one week event. We recommend however, organizing two more comeback sessions within the first year. These comeback sessions can be one or two days, depending on the complexity of the suggested improvements. The reason for these sessions is that organizational changes come with resistance to change and the process of learning. Since both of these phenomena take time, Philips needs to guard the change process to make sure the Kaizen Event is a success.

Contents

The Philips Kaizen consultants conduct an Extended Quick Scan[m] before the Kaizen Event at the healthcare facility. The Extended Quick Scan is a one day event that provides the Philips consultants with a clear picture of the current status of the MRI scanning process. The Extended Quick Scan is the opportunity for the Kaizen consultants to pinpoint problem areas within the MRI scanning process and present the findings to the customer. These findings consist of a plan for the Kaizen Event.

[m] Extended Quick Scan is a service within the consulting services, see Figure 1.1

The customer can then decide whether to continue with the Kaizen Event or not. At the Kaizen Event itself the consultants make further observations and detailed investigations of the MRI scanning process to formulate improvement suggestions, and implement them. The suggested improvements come more from gut feeling and experience than from proved systems, software tools, and best practices. Therefore we see opportunities for the Philips consultants to further professionalize the Kaizen Event. We recommend the Philips consultants to work more with SOPs (Standard Operating Procedures) to arrive at the suggested improvements. One of these SOPs should be the best practice of the MRI scanning process. The best practice describes the "ideal" MRI scanning process. We note that there is no ideal MRI scanning process since there can be numerous constraints to the optimal solution. The constraints can be the layout, limited personnel resources or all kinds of regulatory issues that stop the healthcare facility from reaching the ideal MRI scanning process. However, if we know the ideal process it will be helpful for the Kaizen consultants since they can then find out which parts of this ideal process are possible for the specific healthcare facility on site.

Best practice for MRI scanning process

In this section we make a start with the best practice of the MRI scanning process, by taking elements from the MRI scanning process from the radiology institute in Kapfenberg, which was one of our case study objects. The reason we take this particular institute as a reference is because we noticed it has a well organized and efficient MRI scanning process. Next to this, some best practice elements come from the Philips Kaizen consultants. Next we show the best practice for the MRI scanning process.

Best practice MRI scanning process
Planning - Full flexible planning (no anatomy blocks) - Set time slots to actual exam duration Layout - Administration/planning, MRI scanner room and radiologists close to each other Resources - Two dressing rooms (in case of one MRI scanner) or four dressing rooms (in case of two MRI scanners in the same area) - Two technologists (in case of one MRI scanner) or three technologists (in case of two MRI scanners in the same area) Internal communication/personnel roles - Install intercom near technologists to make radiologist clear that he/she is needed at the MRI scanner (e.g. for revising images) - Appoint one technologist with great experience to fulfil a “spindle” role within the MRI scanning process. His/her main activity should be constantly guarding the total process by communicating with administration/planning, technologists and radiologists, next to being a patient handler External communication - When a patient MRI exam request comes in, ask if the patient is he/she has no physical restrictions to undergo the MRI exam - Technologist should inform patient about what is going to happen prior to entering the MRI room (e.g. in the dressing room) No-shows procedure - Remind first three and last three patient of the day one day in advance of their

appointment by a telephone call - When an appointment is planned, ask the patient how long it will take him/her to get to the healthcare facility in an ad-hoc situation, so that flexible patients can be called in case of a no-show of an other patient - Send confirmation letter regarding the appointment to the patient's home address Activities - Perform all possible patient preparation activities prior to patient entering the MRI room Scanning - Implement best practice Examcards for ankle, knee and spine (if not an academic healthcare facility)

Table 6.1: Best practice for MRI scanning process

When a Kaizen Event is (not) an applicable improvement method

We found in our case study in Germany that our value model may indicate that time savings are possible, but that a Kaizen Event would not make sense since larger improvements could be realized by changing layout and reallocating personnel staff. This means that, the choice to conduct a Kaizen Event at a healthcare facility should depend on the current state of the facility's process. Van Houdenhoven (2007) differentiates improvements for healthcare facilities between strategic, tactical and operational level. In Figure 6.1 we show which problems the Kaizen Event can tackle (green box), and for which problems a more radical approach is necessary (black dashed box).

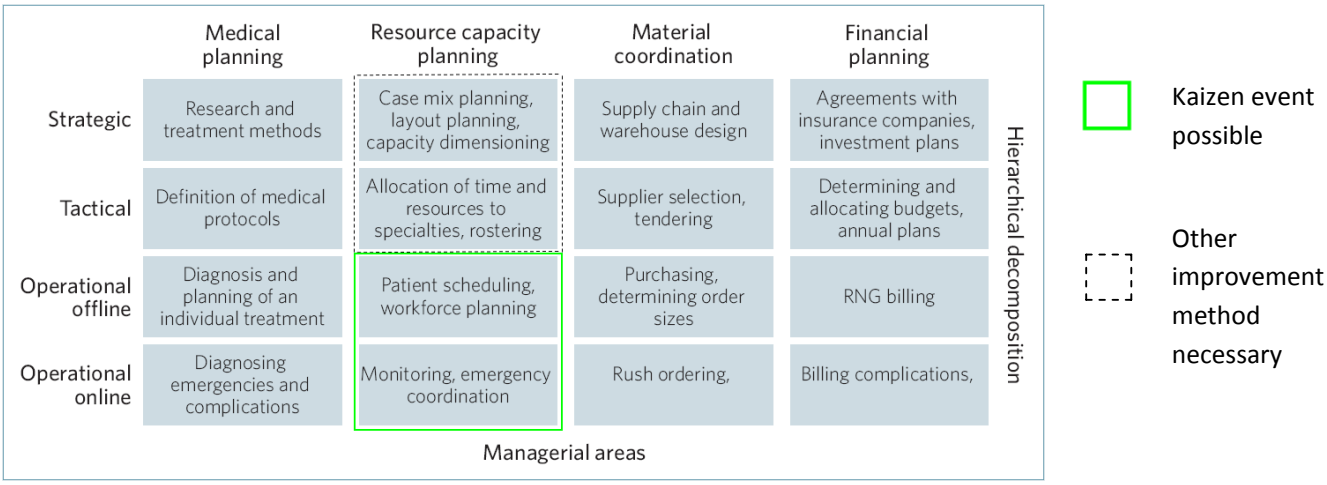

Figure 6.1: Framework for hospital planning and control (Van Houdenhoven, 2007)

We see that the Kaizen Event can tackle operational planning problems, but not tactical and strategic planning problems. It is interesting for Philips to find out what approaches may be useful in the situations where the healthcare facility still faces strategic and tactical planning problems.

Kaizen literally means "continuous improvement" in Japanese. This is the second feature of Total Quality Management (TQM), after the company's focus on its customers[n]. Philips indeed focuses on small improvements in the MRI scanning process with the Kaizen Events. Simon (1994) explains when TQM, and thus the Kaizen Event, can be used as an improvement method, and when Business Process Reengineering (BPR) for more radical changes is needed. See Figure 6.2.

[n] Reid, R.D. and Sanders, N.R. (2001), "Operations management", international edition, *John Wiley & Sons Inc.*, pp. 112

	TQM	BPR
Level of change	Incremental	Radical
Starting Point	Existing process	Clean slate
Frequency of change	One-time/continuous	One-time
Time required	Short	Long
Participation	Bottom-up	Top-down
Scope	Narrow, functional	Broad, cross functional
Risk	Moderate	High
Primary Enabler	Statistical control	Information technology
Type of change	Cultural	Cultural/structural

Figure 6.2: Differences TQM and BPR (Simon, 1994)

As we see from Figure 6.2, BPR is a more applicable process improvement method when radical changes are necessary. As we indicate from Figure 6.1, radical changes like layout change or personnel staff reallocation are needed in the case of strategic and tactical planning problems.

We recommend Philips to investigate for a potential Kaizen Event customer whether a Kaizen Event is suitable, by thoroughly mapping all existing problems and placing the customer in the matrix from Figure 6.1. If strategic and/or tactical planning problems need to be solved first, then we recommend implementing a BPR cycle first. Guha's process reengineering life cycle[o] is a comprehensive tool for a BPR cycle.

Van Houdenhoven's matrix already appeared to be useful for assessing the possibility of a Kaizen Event during our case study at Krankenhaus der Barmherzigen Brüder in Germany. For that hospital, a Kaizen Event is not the best option. With the two MRI scanners on different floors and insufficient amount of dressing rooms, improvements can be realized with respect to layout planning (strategic). Next to

[o] Guha, S., Kettinger W.J., & Teng T.C. (1993), "Business Process Reengineering: Building a Comprehensive Methodology

this, it happens often that only one technologist is managing the MRI scanner and the patient-change-over process. Improvements can be realized here with respect to resource allocation and rostering (tactical). To summarize, we recommend realizing higher level improvements first before conducting a Kaizen Event at Krankenhaus der Barmherzigen Brüder.

6.2.2 Value-based pricing

Currently, the Kaizen Events are priced based on consultation costs + margin. However, we argue that a more powerful pricing tool can be adopted if the supplier can demonstrate value in a convincing way that leads to higher margins for the supplier, namely value-based pricing.

Pricing is an important and largely neglected tool in industrial marketing—on average, a 5% price increase leads to a 22% improvement in operating profits—far more than other tools of operational management. However, the subject of pricing has received far less attention than other aspects of marketing, from both practitioners as well as academic scholars (Hinterhuber, 2003).

Anderson, Kumar and Narus (2007) raise the question of what part of the realized total net value to retain as a profit and what part to share with the customer as an incentive to purchase. This is a strategic decision. The business must decide on its marketing strategy, one element of which is the pricing strategy. Basically, there are two alternatives:

(1) Penetration pricing	In this case the firm intends to make its overall profits through selling a large number of units at a lower profit per unit. Here Philips would be giving all the incremental value to the customer as an incentive to purchase.

(2) Skimming pricing	In this case the firm intends to make its overall profits through selling fewer units at a higher profit per unit. Here Philips gives only enough of the incremental value as customer incentive to purchase to keep the net value for the customer above zero.

Since we can demonstrate the value of a Kaizen Event in a convincing way to the customer, we recommend introducing value-based pricing as a pricing tool. The way to distribute the realized value, and thus the pricing strategy, depends on Philips' marketing strategy.

6.2.3 Business models for Kaizen Event

Philips is currently selling the Kaizen Events as a standalone service. There are however possibilities to combine Kaizen Events with other Philips offerings, like pay-per-use or in a total package where Philips manages the MRI department. We briefly discuss our view here.

Kaizen Event in combination with "pay-per-use"

Pay-per-use is offered as a financial solution for healthcare equipment purchases. Let us say that a healthcare facility wants to acquire an MRI scanner. Then pay-per-use works as follows: the healthcare facility does not pay anything up front. It only pays a fixed amount to Philips for every exam it conducts. If the MRI scanner costs, say, 1,500,000 euro with a lifetime of 7 years and the healthcare facility conducts on average 5,000 exams per year, then the (simplified) pay-per-use price is:

$$\frac{1{,}500{,}000 \text{ euro}}{5{,}000 \text{ exams x } 7 \text{ years}} = 42.85 \text{ euro}^{p}$$

Then if, with a Kaizen Event, we increase the number of expected exams to 5,500 per year and this results in a net value of 50,000 euro per year, Philips can share the net value (value-based pricing) according to for example a 80/20 ratio, where the healthcare facility gets the lion share. This means Philips should incorporate 70,000 euro (=10,000 euro x 7 years) in the total cost of ownership of the MRI scanner. The new pay-per-use calculation then is:

$$\frac{1{,}570{,}000 \text{ euro}}{5{,}000 \text{ exams x } 7 \text{ years}} = 44.85 \text{ euro}$$

This way Philips still receives the 70,000 euro part of total realized net value, but the healthcare facility does not have to pay this amount in one time upfront, which may be a big obstacle and a deal breaker.

Kaizen Event by managing the MRI department

Another way of incorporating Kaizen Events in a Philips solution is by managing the MRI department of the healthcare facility. This is a business model that Philips wants to adopt in the future, where Philips buys all MRI machinery, sells them to a bank and leases them back. The main implication is that Philips takes over some business risks from the hospital. This way it is in Philips' own direct interest to have the MRI department as efficient as possible, hence the link with the Kaizen Events.

[p] This is a simplified calculation, for example without consideration of discounting.

6.2.4 Suggestions for further research

Conceptualizing access time reduction

We identified the social benefit of a Kaizen Event to be access time reduction. We understand that access time can be different for different types of exams. This can for example be the case when the healthcare facility schedules same types of exams in blocks, so that for example the entire Monday morning is reserved for brain exams. In this research we did not conceptualize access time reduction concretely. We recommend investigating how access time reduction can be conceptualized. We suggest looking into queuing theory[q] as a basis to accomplish this.

Understanding reimbursement schemes

During the case studies we interviewed the healthcare facility's staff regarding the MRI reimbursement system of their country, in order to understand the monetary benefits for the customer. It would be helpful if Philips performs a study to fully understand the different MRI reimbursement systems worldwide, so that the monetary benefit of the Kaizen Event is clear.

More specifically than investigating reimbursement systems, we recommend investigating what the monetary benefit in case there is a DRG system (Diagnose Related Groups) applicable in the country. We encountered the DBC system (Diagnose Behandel Combinatie) during our case study in The Netherlands, which is the Dutch version of DRG, and it appeared that it is not easy to understand where the monetary benefit from more MRI exams comes from because of the complexity of the reimbursement system.

[q] See for example "Factory Physics", by W. Hopp and M. Spearman

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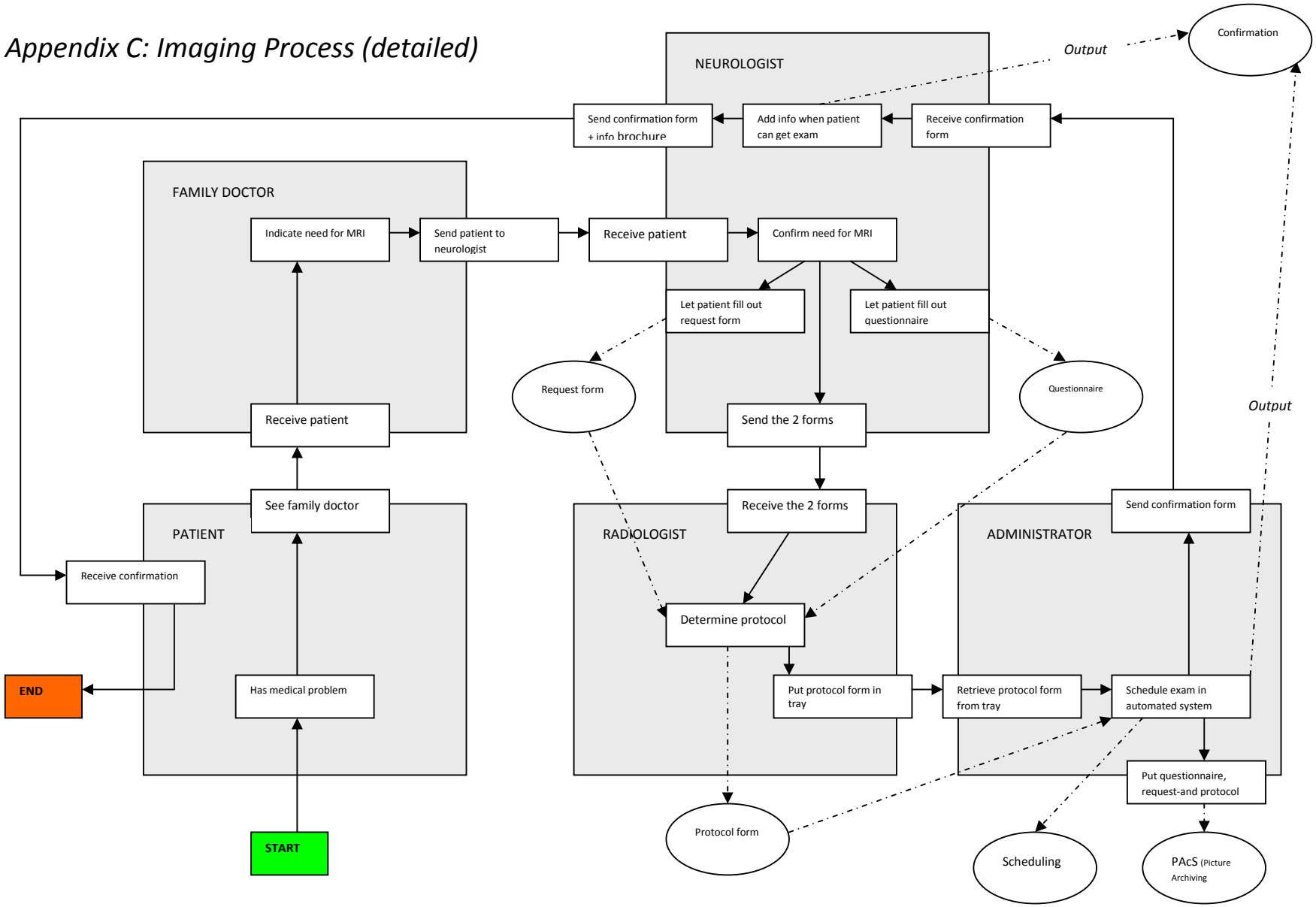
Appendix A: Figures and tables

Appendix B: Terminology and abbreviations

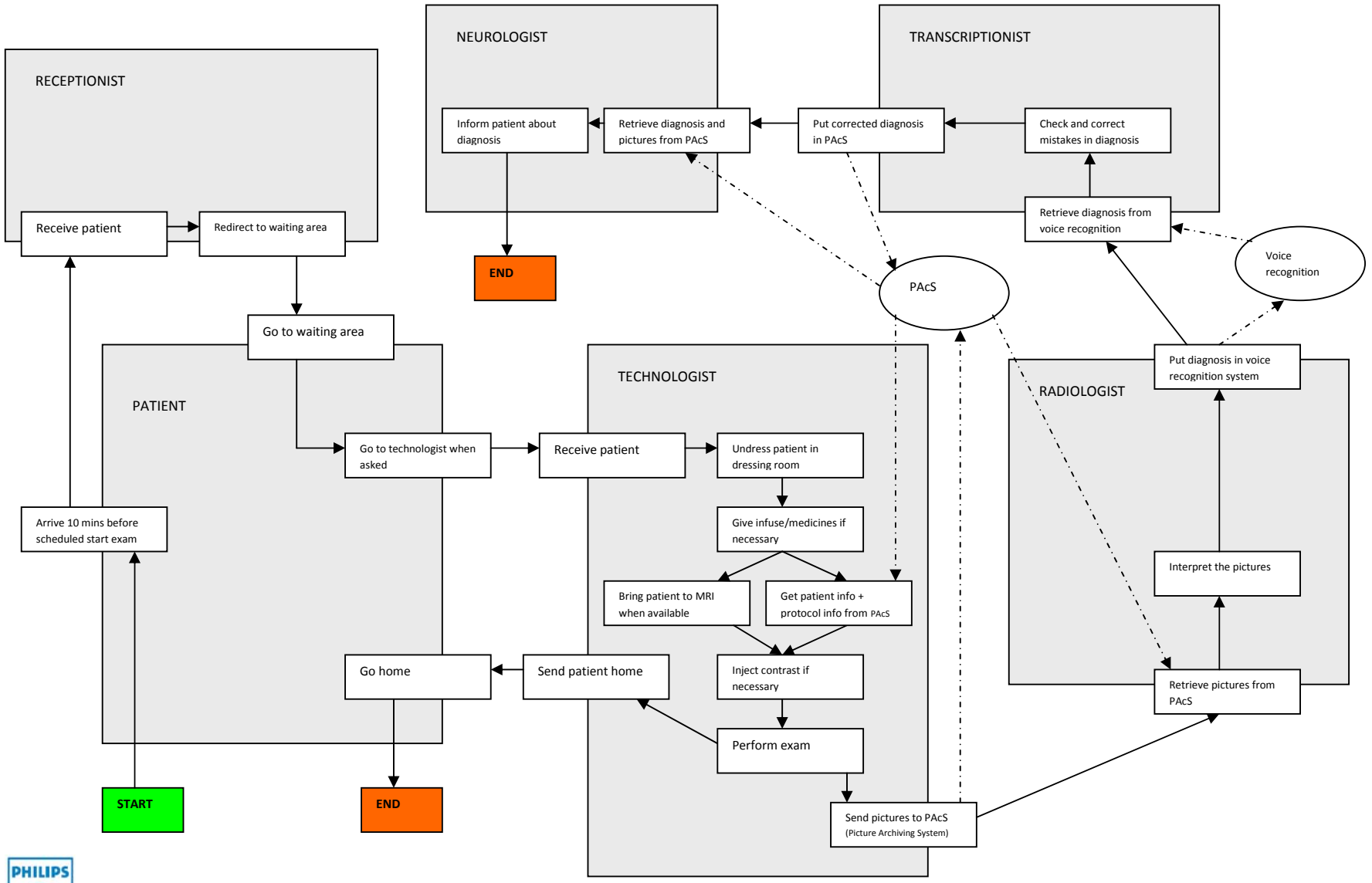
Terminology	
Utilization services	A package of different services that is designed to help healthcare facilities using Philips equipment more efficiently
NetForum	The brand name for the internal Philips database that contains remotely gathered data regarding the MRI scanner(s) of the customer
Healthcare facility	An organization that could have an MRI scanner, like a hospital or an imaging centre
Access time	The time between patient requesting an MRI exam and patient arriving at the healthcare facility to get the MRI exam

Abbreviations	
MRI	Magnetic Resonance Imaging
DRA	Deficit Reduction Act
B2B	Business-to-business
B2C	Business-to-consumer
VC	Value for the Customer
PAcS	Picture Archiving System
RIS	Radiology Information System
IV	Intravenous
KPI	Key Performance Indicator
VWE	Value Word Equation
SOP	Standard Operating Procedure

TQM	Total Quality Management
BPR	Business Process Reengineering
DRG	Diagnose Related Groups
DBC	Diagnose Behandeling Combinatie
C.O. time	Change-over time
P.C.O. time	Patient-change-over time



"Receiving the order" – "confirming the exam"



"Receiving the patient" – "delivering the report"

Appendix D: Set of questions for case study interviews

Interviewees

- Manager (30-60 mins)

- Radiologist (30-60 mins)

- Technologist (15-30 mins)

- Planner/scheduler (15-30 mins)

- Finance & accounting (15-30 mins)

The contents of the interview with manager and radiologist are the same.

Case study questions

<u>Manager/radiologist</u>

Goal: To find out the perceived benefits of exam duration reduction

- What are for you the benefits of time savings in exam duration? (= higher utilization)

    - More money (reimbursement)
    - Cost savings
    - Reduced waiting list
    - …

- What are for you the benefits of reduced waiting list?

◦ Better reputation

◦ Higher patient satisfaction

- How is the government involved in waiting list control?

- Do you get bonus for low waiting list?

- Do you have cost savings for low waiting list (less penalties)?

- How do you benefit from better reputation?

◦ Will you get more patients? How does this benefit you? (more negotiation power for reimbursements? How much more you get?)

◦ Will you get better doctors? (more negotiation power for reimbursements? How much more you get?)

◦ …

- How do you benefit from higher patient satisfaction?

◦ Do you get more patients?

◦ What other benefits do you perceive from higher patient satisfaction?

- How does your MRI reimbursement work?

◦ DRG system?

◦ How you allocate an MRI scan to a DRG revenue stream?

◦ Source insurance company?

◦ Other sources?

◦ Do you get more reimbursed for extra exams? Fixed amount for every exam, or differs per type of exam? Any ceilings on number of exams that are reimbursed?

◦ Do you have access to other countries' reimbursement schemes?

- What do you think the differences in perceived benefits of reduced exam duration are for public vs. private and academic vs. non-academic?

Technologist

Goal: To find out patient-change-over procedure activities and resources.

This allows us to see what activities the hospital is doing, which are superfluous, which are necessary. For the value calculation an internal benchmark will be used, but this information can be used for using an external benchmark later on.

- Go through the patient-change-over procedure with technologist and map the activities and resources.

Planner/scheduler

Goal: To find out current exam scheduling system.

This allows us to calculate the time savings that can come from the Kaizen Event improvements regarding MRI exam scheduling.

- What time slots are you using for the different exams?

- How much unscheduled time do you have on average per day?

- Do you use "block" planning?

- Are there certain radiologist only on specific days available?

- What is the priority rule? (FCFS?)

- What is the logistical KPI? (access time, utilization scanner, waiting time)

Finance & accounting

Goal: To find out the reimbursement scheme and how DRG is allocated

- See questions regarding MRI reimbursement in radiologist/manager questions.

Appendix E: Calculations of Value Word Equations case study "Ziekenhuis Rijnstate, The Netherlands"

VWE 1: Net scan time reduction (mins):

current net scan time – net scan time of top 10 performer

We can reduce the net scan time for knee, ankle and spine exams. In Rijnstate's Pareto exams are the knee and spine anatomies. Next we display Rijnstate's current net scan time together with our top 10 performer's net scan time.

Anatomy	*Net scan time (Rijnstate)*	*Net scan time (top 10 performer)*
Knee	11:30 mins	10:30 mins
Spine (L spine)	09:30 mins	11:00 mins
Spine (C spine)	14:15 mins	09:45 mins

We know for Rijnstate that a knee exam is conducted 14.7% of total exams and for spine goes 23.7%. We do not have information to split up lumbar and cervical spine. Therefore, we simply take 11.85% for both exam types. We now can calculate the time savings for an average exam:

Exam duration reduction = (0.147 X 1:00 mins) + (0.1185 X 4:30 mins) = 0:45 mins

VWE 2: No-shows time reduction (mins):

if
- **no-shows is between 5%-10% → [(current no-shows-% - 5%) X current examination duration]**
- **no-shows is >10% → [(current no-shows-% - 10%) X current examination duration]**

For the month May the no-shows were measured at Rijnstate. The result is 30 no-shows, for the two MRI scanners. The no-shows percentage can be calculated by dividing the no-shows by the total exams for that month:

Total exams in May: 925

# of no-shows in May: 30

No-shows percentage: 30 / 925 = 3.25%

This is lower than the 5% mentioned in the Value Word Equations, so no benefit can be realized here.

VWE 3: Unused time slots time reduction (mins):

$$\Sigma(i) = \frac{[\text{current scheduled time for exam i} - (\text{gross scan time exam i} + \text{patientchangeover time exam i})]}{i}$$

Next we present the Pareto exams with their current scheduled times. The percentages indicate the frequency of occurrence.

Exam	*Current scheduled time in time slot*
Brain (35%)	20 mins
Spine (24%)	20 mins
Breast (10%)	25 mins

The new scheduled time in a time slot should be based on the gross scan time + new patient-change-over time (see VWE 5 for new P.C.O. time):

Exam	*Current scheduled time*	*Gross scan time*	*P.C.O. time*	*New scheduled time*
Brain (35%)	20 mins	13:00 mins	5:40 mins	20:00 mins
Spine (24%)	20 mins	10:25 mins	5:40 mins	15:00 mins
Breast (10%)	25 mins	12:00 mins	5:40 mins	20:00 mins

These exams make up about 70% of total exams. The time savings can be calculated by multiplying the time savings per exam type by the frequency in which they occur.

Exam duration reduction = (0.24 x 5:00 mins) + (0.10 x 5:00 mins) = 1:40 mins

VWE 4: Unscheduled time reduction (mins):

$$\frac{\text{current unscheduled time per day} - 15\text{mins}}{\text{current average \# exams per day}}$$

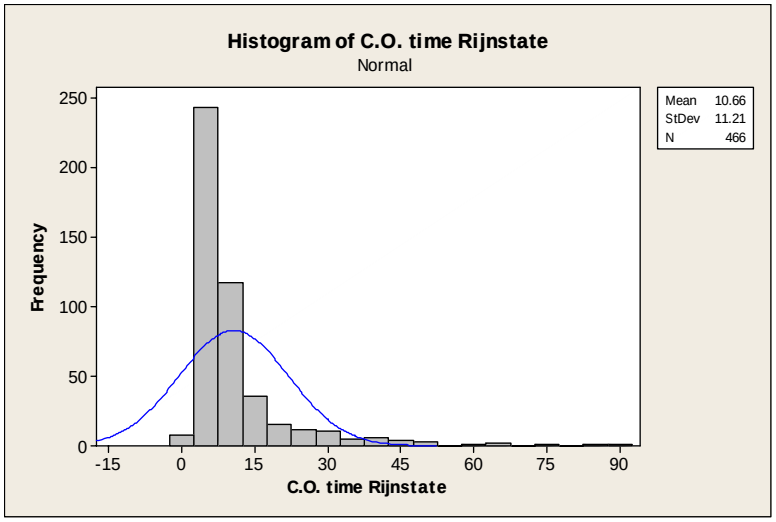
For the month May we found how much time is unscheduled. The schedule we retrieved from the IT system of the hospital did not include all last minute changes, so we had to adjust for this with our NetForum database. In NetForum we can see which exams were actually done. We had to adjust these data again with no-shows, since no-shows are planned but, of course, not visible in NetForum. This resulted in an actual unscheduled time of 01:35 hours per day on average. The current average number of exams per day is 18. This allows us to calculate this equation.

Exam duration reduction = (95:00 mins – 15:00 mins) / 18 = 4:25 mins.

VWE 5: Patient-change-over time reduction (mins):

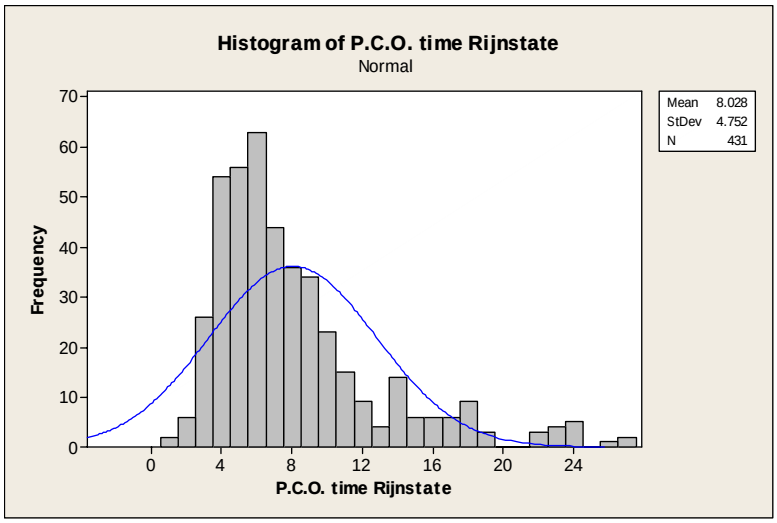
½σ of current average patient-change-over time

We display Rijnstate's current change-over time next.



Descriptive Statistics: C.O. time Rijnstate			
Mean	10.664	StDev	11.215
Min	0.800	Max	10.700
Q1	5.000	Q3	10.700
IQR	5.700		

After deleting the outliers according the IQR outlier analysis, we can show the patient-change-over distribution. Current P.C.O. time is 8:00 minutes.



Descriptive Statistics: P.C.O. time UZ Brussel			
Mean	8.028	StDev	4.752
Min	0.800	Max	27.200

With a Kaizen Event, we can reduce the average patient-change-over by ½σ, which results in a time savings of 2:20 minutes and a new patient-change-over time of 5:40 minutes.

Appendix F: Calculations of Value Word Equations case study "Universitair Ziekenhuis Brussel, Belgium"

VWE 1: Net scan time reduction (mins):

current net scan time – net scan time of top 10 performer

Since UZ Brussel is an academic hospital, we can not realize exam duration with respect to this area.

VWE 2: No-shows time reduction (mins):

if
- **no-shows is between 5%-10% → [(current no-shows-% - 5%) X current examination duration]**
- **no-shows is >10% → [(current no-shows-% - 10%) X current examination duration]**

For the month May the no-shows were measured at UZ Brussel. The result is 65 no-shows, for the two MRI scanners. The no-shows percentage can be calculated by dividing the no-shows by the total exams for that month:

Total exams in May:	1,275
# of no-shows in May:	65
No-shows percentage:	65 / 1,275 = 5.1%

This is close to the 5% mentioned in the Value Word Equations, so no benefit can be realised here.

VWE 3: Unused time slots time reduction (mins):

$$\Sigma(i) = \frac{[\text{current scheduled time for exam i} - (\text{gross scan time exam i} + \text{patientchangeover time exam i})]}{i}$$

Next we present the Pareto exams with their current scheduled times. The percentages indicate the frequency of occurrence.

Exam	*Current scheduled time in time slot*
Brain (33%)	30 mins
Spine (22%)	30 mins
Knee (14%)	30 mins

The new scheduled time in a time slot should be based on the gross scan time + new patient-change-over time (see VWE 5 for new P.C.O. time):

Exam	*Current scheduled time*	*Gross scan time*	*P.C.O. time*	*New scheduled time*
Brain (33%)	30 mins	19:00 mins	5:45 mins	25:00 mins
Spine (22%)	30 mins	17:00 mins	5:45 mins	20:00 mins
Breast (14%)	30 mins	22:30 mins	5:45 mins	25:00 mins

These exams make up about 70% of total exams. The time savings can be calculated by multiplying the time savings per exam type by the frequency in which they occur.

Exam duration reduction = (0.33 x 5:00 mins) + (0.22 x 10:00 mins) + (0.14 x 5:00 mins) = 4:30 mins

VWE 4: Unscheduled time reduction (mins):

$$\frac{\text{current unscheduled time per day} - 15\text{mins}}{\text{current average \# exams per day}}$$

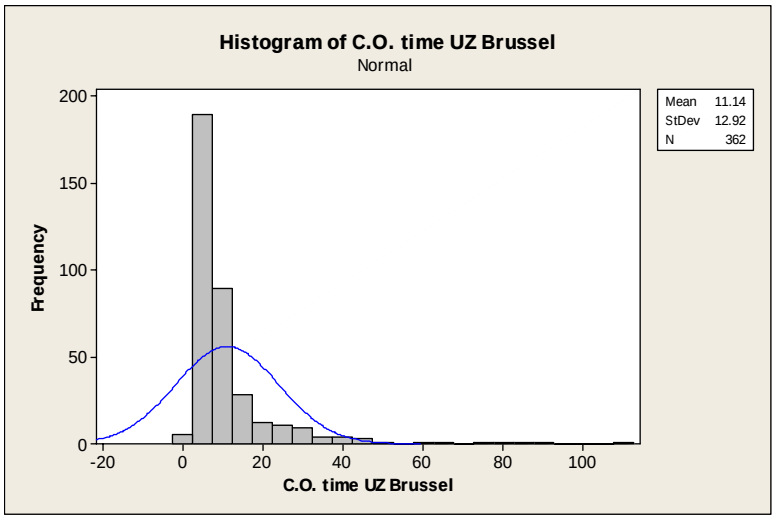
For the month May we found how much time is unscheduled. The schedule we retrieved from the IT system of the hospital did not include all last minute changes, so we had to adjust for this with our NetForum database. In NetForum we can see which exams were actually done. We had to adjust these data again with no-shows, since no-shows are planned but, of course, not visible in NetForum. This resulted in an actual unscheduled time of 00:35 hours per day on average. The current average number of exams per day is 26. This allows us to calculate this equation.

Exam duration reduction = (35:00 mins – 15:00 mins) / 26 = 00:45 mins

VWE 5: Patient-change-over time reduction (mins):

½σ of current average patient-change-over time

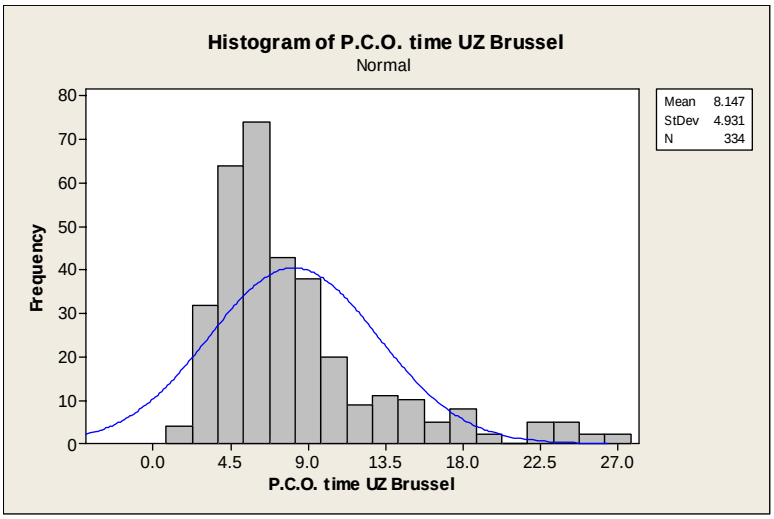
We display UZ Brussel's current change-over time next.



Descriptive Statistics: C.O. time UZ Brussel

Mean	11.136	StDev	12.919
Min	1.117	Max	109.933
Q1	5.012	Q3	10.712
IQR	5.700		

After deleting the outliers according the IQR outlier analysis, we can show the patient-change-over distribution. Current P.C.O. time is 8:10 minutes:



Descriptive Statistics: P.C.O. time UZ Brussel

Mean	8.147	StDev	4.931
Min	1.117	Max	27.183

With a Kaizen Event, we can reduce the average patient-change-over by ½σ, which results in a time savings of 2:25 minutes and a new patient-change-over time of 5:45 minutes.

Appendix G: Calculations of Value Word Equations case study "Krankenhaus der Barmherzigen Brüder, Germany"

VWE 1: Net scan time reduction (mins):

current net scan time – net scan time of top 10 performer

Since Krankenhaus der Barmherzigen Brüder is an academic hospital, we can not realize exam duration with respect to this area.

VWE 2: No-shows time reduction (mins):

if
- **no-shows is between 5%-10% → [(current no-shows-% - 5%) X current examination duration]**
- **no-shows is >10% → [(current no-shows-% - 10%) X current examination duration]**

We could not retrieve information that allows us to calculate the number of no-shows. For that reason we can not account for any time savings here.

VWE 3: Unused time slots time reduction (mins):

$$\Sigma(i) = \frac{[\text{current scheduled time for exam i} - (\text{gross scan time exam i} + \text{patientchangeover time exam i})]}{i}$$

Next we present the Pareto exams with their current scheduled times. The percentages indicate the frequency of occurrence.

Exam	*Current scheduled time in time slot*
Brain (55%)	30 mins
Spine (15%)	35 mins
Knee (7%)	45 mins

The new scheduled time in a time slot should be based on the gross scan time + new patient-change-over time (see VWE 5 for new P.C.O. time):

Exam	*Current scheduled time*	*Gross scan time*	*P.C.O. time*	*New scheduled time*
Brain (55%)	30 mins	21:00 mins	6:50 mins	30:00 mins
Spine (15%)	35 mins	19:00 mins	6:50 mins	25:00 mins
Knee (7%)	45 mins	29:30 mins	6:50 mins	35:00 mins

These exams make up about 75% of total exams. The time savings can be calculated by multiplying the time savings per exam type by the frequency in which they occur.

Exam duration reduction = (0.15 x 10:00 mins) + (0.07 x 10:00 mins) = 2:10 mins

VWE 4: Unscheduled time reduction (mins):

$$\frac{\text{current unscheduled time per day} - 15\text{mins}}{\text{current average \# exams per day}}$$

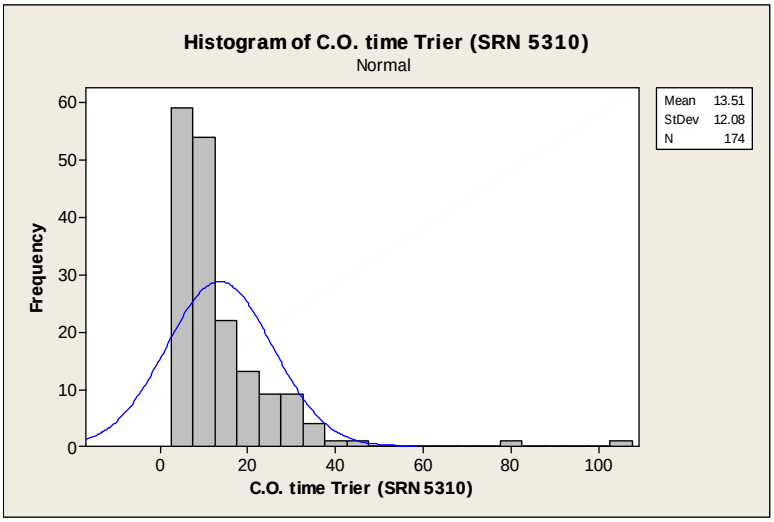
We were not able to retrieve the realization of the schedule, because this information is not well recorded at Krankenhaus der Barmherzigen Brüder. Therefore, we can not account for any time savings here.

VWE 5: Patient-change-over time reduction (mins):

½σ of current average patient-change-over time

Krankenhaus der Barmherzigen Brüder has two MRI scanners on different floors in the hospital, which means the patient-change-over can be different. We calculate the time savings here separately per MRI scanner, and then take the average of the time savings.

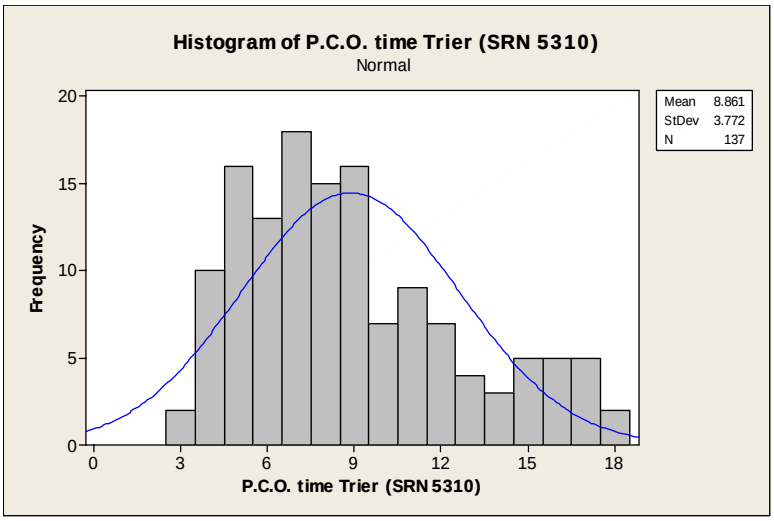
MRI scanner 1 (SRN 5310)



Descriptive Statistics: C.O. time Trier (SRN 5310)

Mean	13.514	StDev	12.079
Min	3.050	Max	104.217
Q1	6.517	Q3	16.850
IQR	10.333		

After deleting the outliers according the IQR outlier analysis, we can show the patient-change-over distribution. Current P.C.O. time is 8:50 minutes:

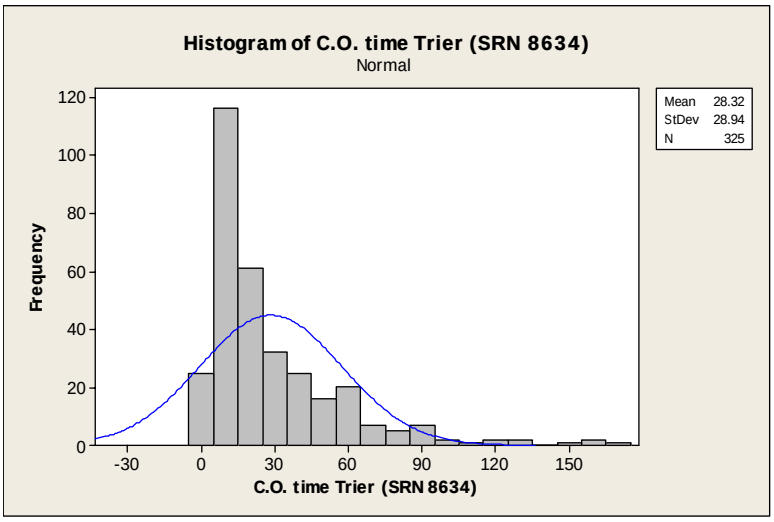


Descriptive Statistics: P.C.O. time Trier (SRN 5310)

Mean	8.861	StDev	3.772
Min	3.050	Max	18.000

With a Kaizen Event, we can reduce the average patient-change-over by ½σ, which results in a time savings of 1:55 minutes and a new patient-change-over time of 6:55 minutes.

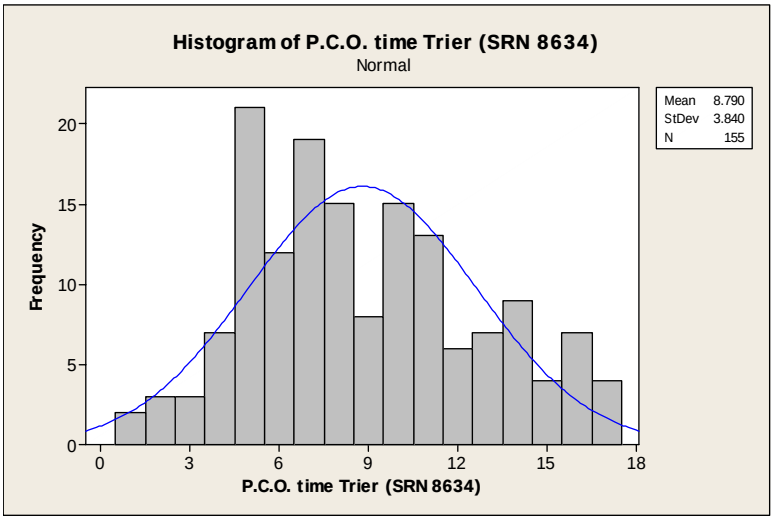
MRI scanner 1 (SRN 8634)



Descriptive Statistics: C.O. time Trier (SRN 8634)

Mean	28.32	StDev	28.94
Min	1.10	Max	170.67
Q1	8.37	Q3	36.83
IQR	28.47		

After deleting the outliers according the IQR outlier analysis, we can show the patient-change-over distribution. Current P.C.O. time is 8:45 minutes:



Descriptive Statistics:
P.C.O. time Trier (SRN 8634)

Mean	8.790	StDev	3.840
Min	1.100	Max	17.117

With a Kaizen Event, we can reduce the average patient-change-over by ½σ, which results in a time savings of 1:55 minutes and a new patient-change-over time of 6:50 minutes.

Average for two MRI scanners

For both MRI scanners we can realize 1:55 minutes time savings, so the average exam duration reduction is 1:55 minutes.

Appendix H: Value proposition for "ziekenhuis Rijnstate, The Netherlands"

Value proposition for a Kaizen Event

For ziekenhuis Rijnstate,The Netherlands

Dear Jan Twilhaar, dear Marc van Driel,

In front of you lies the value proposition for a Kaizen Event for the MRI department in your hospital. The findings are based on our visit to your hospital, on the 4th of June 2009.

Our intentions are to show you how your hospital can benefit from the Philips Kaizen Event. We can improve your workflows and realize exam duration reduction. This allows you to better utilize your MRI scanners and increase your exam throughput.

We hope you enjoy reading this document. We would appreciate it if you can give us feedback on our proposal. For example, if particular issues are unclear to you, figures are incorrect, or simply if you question some conclusions we make.

We thank you for giving us all required information and for cooperating in the case study.

Best regards,

Marcel van Viegen

Trainee MRI Kaizen Events
Philips Healthcare, Eindhoven

John Paul Kuwornu

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Utilization Services and NetForum Community
Philips Healthcare, Best

Milo Schoonheijm

Customer Finance Manager
Philips Healthcare Solutions
Philips Healthcare, Eindhoven

*"The Philips Kaizen Event can generate **5,050 extra MRI exams** in the first year for ziekenhuis Riinstate"*

Summary

On the 4th of June 2009 we visited ziekenhuis Rijnstate with the purpose of finding out the value of a Philips Kaizen Event for ziekenhuis Rijnstate. We do this by applying a value model and cost model developed by Philips. These models explain how value is created with a Kaizen Event and what the benefits are for ziekenhuis Rijnstate with consideration of the cost implications.

The current average exam duration is 28 minutes. Philips can realize improvements in the MRI scanning process so that exam duration will reduce to approximately 18 minutes and 50 seconds. We do this by implementing more efficient Examcards, changes in the time slots for exams, adjusting the planning system and improving the patient-change-over procedure.

The improvements will lead to roughly 2,525 extra exams per MRI scanner per year. For the two scanners in ziekenhuis Rijnstate this means a total of 5,050 extra exams per year. Our value model shows the benefits for ziekenhuis Rijnstate of these increased exams. The DBC system does not directly reward extra exams in monetary terms since there is a fixed budget for a year. However, there is a delayed monetary reward, since every year new negotiations are made regarding the expected number of MRI exams. If Rijnstate shows to the insurer that they are conducting more exams, it is likely that Rijnstate receives higher reimbursement in next years.

Next to the monetary value, there is a social benefit, namely a reduction in access time for the patients. Furthermore, Rijnstate will benefit from the Philips consultants because external advisors are perceived as more objective and more credible than internal advisors. This will result in an easier change and implementation process.

The extra exams will also cause costs to increase. The incremental cost for an extra exam is € 17.04. Multiplied by the 5,050 extra exams, this leads to € 86,000.- extra costs per year. The costs of an extra radiologist are € 200,000.- per year. Other costs that have to be incurred in order to make the Kaizen Event to a success are € 6,125.-.

Contents

1. How we create value

We start with explaining how we create value with a Philips Kaizen Event. We do this by reducing exam duration. In order to reduce exam duration, we have to understand exam duration. For that reason we split exam duration up into lowest-level time components which individually we can understand and measure.

Exam duration consists of two sequential steps: (1) gross scan time, and (2) change-over time. After delving deeper in these steps we identified in total eight different low-level times:

(1) Gross scan time
- Net scan time
- In-between-protocol-time

(2) Change-over time
- Patient-change-over time
- No-shows time
- Unscheduled time
- Unused time slots time
- Scanner down time
- Preparation time

With a Philips Kaizen Event we can reduce five of these lowest-level time components. For these five, we constructed so called “Value Word Equations”. These equations allow us to conceptualize the potential time savings in a structured way. On the next pages we show the five equations with the results for ziekenhuis Rijnstate.

Equation 1: Net scan time reduction (mins):

Current net scan time - net scan time of top 10 performer worldwide

Ziekenhuis Rijnstate can implement Examcards from the top 10 performer worldwide. We advise adopting more efficient Examcards for spine, knee and ankle. With these changes, Rijnstate will save 45 seconds on average with an exam.

Equation 2: No-shows time reduction (mins):

if
- No-shows is between 5%-10% → [current no-shows-% - 5%] X [current exam duration]
- No-shows is >10% → [current no-shows-% - 10%] X [current exam duration]

We measured the number of no-shows for the month May. There were 30 no-shows out of 925 exams. That is 3.25% no-shows. Our no-shows prevention procedure can reduce the no-shows to approximately 5%. This means we can not realize any time savings here at ziekenhuis Rijnstate.

Equation 3: Unused time slots time (mins):

$$\Sigma(i) = \frac{[\text{ current scheduled time for exam i } - \text{ (gross scan time exam i} + \text{patientchangeover time exam i) }]}{i}$$

For the most performed exams we recommend reconsidering the time slot used for scheduling the exam. The most performed exams are brain, spine and breast, together making up 70% of total exams.

We suggest adjusting the time slots to actual durations, which is gross scan time + patient-change-over time. The new time slots should be:

Exam	*Current time slot*	*Gross scan time*	*P.C.O. time*	*New time slot*
- Brain (35%):	20 mins	13:00 mins	5:40 mins	20:00 mins
- Spine (24%):	20 mins	10:25 mins	5:40 mins	15:00 mins
- Breast (10%):	25 mins	12:00 mins	5:40 mins	20:00 mins

Time savings: (0.24 x 5:00 mins) + (0.10 x 5:00 mins) = 1:40 mins

Equation 4: Unscheduled time reduction (mins):

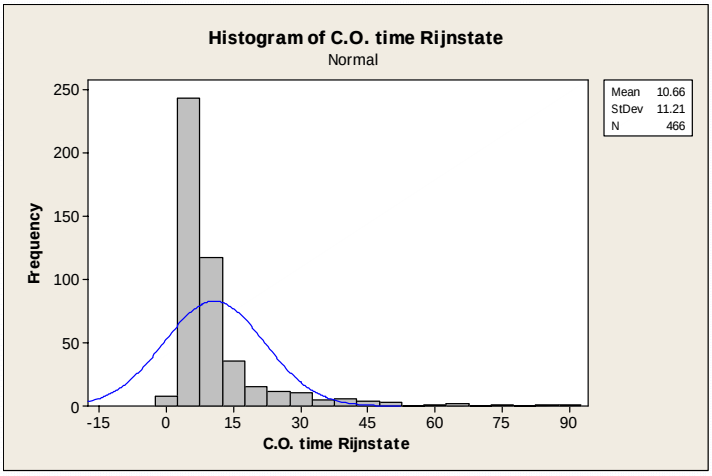
$$\frac{\text{currentunscheduled timeper day } - \text{ 15mins}}{\text{currentaverage \# examsper day}}$$

The current scheduling system of Rijnstate shows holes. This is because the current way of planning is not optimal. We analyzed the month May in 2009 and found that for Rijnstate on average 1 hour and 35 minutes per day is unscheduled time. We can revise the planning system in such a way that Rijnstate saves 4 minutes and 25 seconds per exam with respect to this area.

VWE 5: Patient-change-over reduction (mins):

½σ of current patient-change-over time

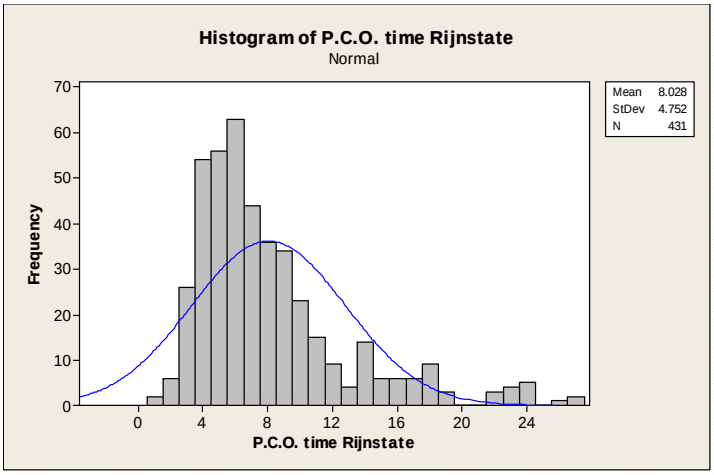
Currently for Rijnstate the average change-over time is 10 minutes and 40 seconds. We retrieve this information from the Philips NetForum Database. The figure below displays the change-over time for Rijnstate:



Descriptive Statistics: C.O. time Rijnstate

Mean	10.664	StDev	11.215
Min	0.800	Max	10.700
Q1	5.000	Q3	10.700
IQR	5.700		

However, as we saw on page 5, patient-change-over is only a part of total change-over time. We can filter the patient-change-over time from above figure by deleting the outliers:



Descriptive Statistics: P.C.O. time UZ Brussel

Mean	8.028	StDev	4.752
Min	0.800	Max	27.200

With the Philips Kaizen Event we can reduce the patient-change-over time by ½σ. The time saving that can be realized here is 2:20 minutes. The new patient-change-over time will be 5:40 minutes.

2. What the benefits are for ziekenhuis Rijnstate

The DBC system does not directly reward extra exams in monetary terms since there is a fixed budget for a year. However, there is a delayed monetary reward, since every year new negotiations are made regarding the expected number of MRI exams. If Rijnstate shows to the insurer that they are conducting more exams, it is likely that Rijnstate receives higher reimbursement in next years.

Next to the monetary value, there is a social benefit, namely a reduction in access time for the patients. Access time is the time a patient has to wait for an MRI exam. Reducing this access time obviously has social value and will result in higher patient satisfaction.

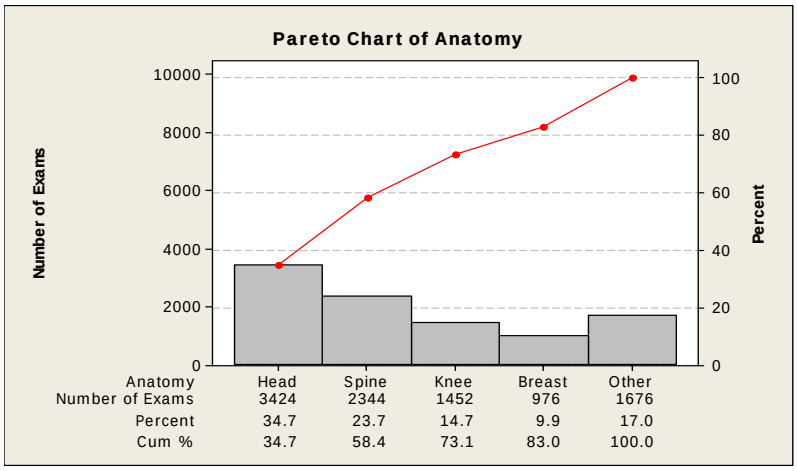
Furthermore, Rijnstate will benefit from the Philips consultants because external advisors are perceived as more objective and more credible than internal advisors. This will result in an easier change and implementation process.

3. Cost implications

The figures (cost and number of examinations) used for the cost analysis are based on estimates. The cost of the two MRI machines and the imaging room come from expert estimate within Philips. The salary of technologist figure comes from gobnet.nl. The number of examinations was based on projection of three months (February to April). The result is structured in the following way: section one discusses the Pareto of exams mix; the second section shows one (out of four) component cost computation. The third section presents the cost price of the four examinations; the fourth section shows the Volume-weighted average MRI examination cost; and the fifth section demonstrate the computation of incremental cost of MRI exams.

3.1 Pareto Chart of Examinations

The chart shows that there are four major types (anatomies) of examinations accounting for 80% of the examinations conducted at Rijnstate: head, spine, knee and breast. We therefore base our cost computations on these four anatomies and compute the cost of each of them. We use the cost of these four types of examinations to compute the average cost of MRI examination in the hospital.



3.2 Examination Cost component Computation

We demonstrate how we compute the technologist cost component of each of the four anatomies. Our analysis is based on 4 technologists working full time on MRI. Their average salary is assumed to be € 30,415 (from gobnet.nl). Table 1 below gives the summary of the results. The result indicates that breast examinations cost more (€ 15.07) in terms of technologist costs and knee examinations are the least costly (€ 13.38). The results also show that out of the about 4,560 hours supplied, about 1,180 hours are not used.

We carry out similar calculations for the MRI machine and the imaging room. We leave out the radiologist cost component because there is a different organizational structure in the hospital. The radiologists are more like entrepreneurs and they share profits rather than earn salaries.

Technologist

	A	B = Hourly rate/60	C = A*B	D	E = A*D	F = C*D
Anatomy	Unit time (minute)	Rate per min	Cost driver rates	Volume	Specified time	Total cost assigned
Head	25.29	€ 0.57	€ 14.39	3424	86,592.96	€ 49,276.40
Spine	24.01	€ 0.57	€ 13.66	2344	56,279.44	€ 32,026.25
Knee	23.52	€ 0.57	€ 13.38	1452	34,151.04	€ 19,433.91
Breast	26.48	€ 0.57	€ 15.07	976	25,844.48	€ 14,707.00
Total used					3,381.13	€ 115,443.57
Total supplied					4,560.90	€ 194,656.00
Unused capacity					1,179.76	€ 79,212.43

Assume salary for technologist is	€ 243,320.00	(€ 30415 per technologist)
Technologist works	5,701.12	(3.4FTEs*262days*8hrs*80%)
Hourly rate	€ 34.14	

Table 1: Technologist cost components

3.3 MRI Examination Costs of the Four Anatomies

Table 2 on the next sheet presents the total cost of the four anatomies. The figures for total variable cost and departmental overhead are just guesses based on insight from other hospitals' costs. We also assume in the computations that hospital overhead cost allocated to MRI examinations is 30% of the total departmental cost. The result indicates that spine examination is the cheapest (€ 104) approximately and the most costly is head examination of € 118 approximately. Using this range of anatomy costs, we compute ***the volume weighted average examination cost to be approximately € 112***. These figures appear in the table in purple.

Time-Driven ABC

	A	B	C	D= A+B+C	E	F = D*E	G = (Ei / ∑ Ei)*1	H = (Fi / ∑ Fi)*2	I =0.3*(F+G+H)	J = (F+G+H+I)/E
Anatomy	Technologist	Machine	Room	Cost driver rates	Number of Examinations	Total Direct Cost Assigned	Variable cost*	Departmental Overhead Allocated	Hospital Overhead Allocated	Cost Per Examination
Head	€ 14.39	€ 10.90	€ 1.42	€ 26.71	3424	€ 91,454.99	€ 20,888.24	€ 198,273.55	€ 93,185.03	€ 117.93
Spine	€ 13.66	€ 8.59	€ 1.19	€ 23.45	2344	€ 54,959.87	€ 14,299.66	€ 119,152.46	€ 56,523.60	€ 104.49
Knee	€ 13.38	€ 9.68	€ 1.28	€ 24.35	1452	€ 35,355.71	€ 8,857.98	€ 76,650.84	€ 36,259.36	€ 108.21
Breast	€ 15.07	€ 10.06	€ 1.30	€ 26.43	976	€ 25,794.92	€ 5,954.12	€ 55,923.15	€ 26,301.66	€ 116.78
Total	€ 56.51	€ 39.23	€ 5.20	€ 100.94	8196	€ 207,565.49	€ 50,000.00	€ 450,000.00	€ 212,269.65	€ 447.42
Avg. cost	€ 14.13	€ 9.81	€ 1.30	€ 25.23						€ 111.85
Avg. time (Min)	24.83	11.70	13.03	49.56						
		[1] Total variable cost (supplies)			€ 50,000.00					
		[2] Total Departmental overhead			€ 450,000.00					
		[3] Hospital overhead @ 30% of department cost								

The volume-weighted average cost of MRI exams is € 112

Table 2: Total cost of MRI examination of the four Anatomies

3.4 Volume-Weighted Average MRI Examination Cost

We computed the average cost of MRI examination to be approximately € 112. Table 3 shows the break down of this average cost. The calculations show that the fixed departmental cost component forms about 39% of the cost. We based this computation on the assumption that 80% of the departmental overhead is fixed while the rest 20% is variable. In total, 85% of the average MRI cost is fixed while 15% is variable. This variable cost component is what goes into the incremental cost calculations.

INCREMENTAL COST ANALYSIS

Composition of volume-weighted MRI cost

Fixed Cost		Cost		Percentage
	Technologist Salary & Benefits	€	14.13	12.63%
	MRI Machine	€	9.81	8.77%
	MRI Room	€	1.30	1.16%
	Fixed Departmental Overhead	€	43.77	39.13%
	Hospital overhead	€	25.81	23.08%
	Sub-total	€	94.81	84.76%
Variable Cost				
	Supplies and other materials	€	6.10	5.45%
	Variable Deparmental Overhead	€	10.94	9.78%
	Sub-total	€	17.04	15.24%
	Total	€	111.85	100.00%

Table 3: Break down of the Volume-weighted Average MRI Examination

3.5 MRI Incremental Cost Analysis

The incremental cost of MRI examination at Rijnstate is € 17.04 (about 15% of the total cost) from the purple shaded row in the table above. The analysis of the value model (the other report) shows that the Kaizen Event is able to generate extra 5,052 examinations per year. Hence the incremental cost of these examinations is € 86,086 (€ 17.04*5,052). This is the figure shown in the other report as incremental cost. This cost together with the cost of hiring additional radiologist would be the total incremental cost of the extra examinations generated by the Kaizen events service.

4. Feedback Section

In our analysis, we made a couple of assumptions. We kindly ask you to provide us with your views on the following issues:

- Do you consider the Pareto of exams as we present to be representative of your exams conducted in 2008? If not, can you provide us with these figures?
- We assumed that 4 technologists work full time on MRI examinations. Is this assumption valid?
- Is the method followed in computing these figures clear enough?
- In your estimation, are the cost figures reported realistic?
- Does the understanding of the cost implications of Kaizen Events consulting service help you in assessing the usefulness of the service?
- What is your opinion on the benefits that we mention in section 2? Do you agree? Would you know any other benefits?
- Do any questions pop up when reading the Value Word Equations? (pg 6-8)
- Overall, how convincing is this value proposition to you?

Appendix I: Value proposition for "Universitair Ziekenhuis Brussel, Belgium"

Universitair Ziekenhuis Brussel

PHILIPS
sense and simplicity

Value proposition for a Kaizen Event

For Universitair Ziekenhuis Brussel, Belgium

Dear Prof. de Mey,

In front of you lies the value proposition for a Kaizen Event for the MRI department in your hospital. The findings are based on our visit to your hospital, on the 12th of June 2009.

Our intentions are to show you how your hospital can benefit from the Philips Kaizen Event. We can improve your workflows and realize exam duration reduction. This allows you to better utilize your MRI scanners and increase your exam throughput.

We hope you enjoy reading this document. We would appreciate it if you can give us feedback on our proposal. For example, if particular issues are unclear to you, figures are incorrect, or simply if you question some conclusions we make.

We thank you for giving us all required information and for cooperating in the case study.

Best regards,

Marcel van Viegen

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Milo Schoonheijm

Customer Finance Manager
Philips Healthcare Solutions
Philips Healthcare, Eindhoven

*"The Philips Kaizen Event can realize a **net value of € 309,000.-***

in the first year for UZ Brussel"

Summary

On the 12th of June 2009 we visited UZ Brussel with the purpose of finding out the value of a Philips Kaizen Event for UZ Brussel. We do this by applying a value model and cost model developed by Philips. These models explain how value is created with a Kaizen Event and what the benefits are for UZ Brussel with consideration of the cost implications.

The current average exam duration is 33 minutes and 30 seconds. Philips can realize improvements in the MRI scanning process so that exam duration will reduce to approximately 25 minutes and 50 seconds. We do this by implementing changes in the time slots for exams, adjusting the planning system and improving the patient-change-over procedure.

The improvements will lead to roughly 1,625 extra exams per MRI scanner per year. For the two scanners in UZ Brussel this means a total of 3,250 extra exams per year. Our value model shows the benefits for UZ Brussel of these increased exams. The Belgium reimbursement system does provide healthcare facilities with revenues for extra exams. The reimbursement differs per type of exam. We calculated that the average reimbursement for an MRI exam is roughly 170 euro. This amount multiplied by the 3,250 extra exams results in a monetary benefit of € 553,180 in the first year.

Next to the monetary value, there is a social benefit, namely a reduction in access time for the patients. Furthermore, UZ Brussel will benefit from the Philips consultants because external advisors are perceived as more objective and more credible than internal advisors. This will result in an easier change and implementation process.

The extra exams will also cause costs to increase. The incremental cost for an extra exam is € 12.76. Multiplied by the 3,250 extra exams, this leads to € 41,500.- extra costs per year. The costs of an extra radiologist are € 200,000.- per year. Other costs that have to be incurred in order to make the Kaizen Event to a success are € 2,625.-.

Contents

1. How we create value

We start with explaining how we create value with a Philips Kaizen Event. We do this by reducing exam duration. In order to reduce exam duration, we have to understand exam duration. For that reason we split exam duration up into lowest-level time components which individually we can understand and measure.

Exam duration consists of two sequential steps: (1) gross scan time, and (2) change-over time. After delving deeper in these steps we identified in total eight different low-level times:

(1) Gross scan time
- Net scan time
- In-between-protocol-time

(2) Change-over time
- Patient-change-over time
- No-shows time
- Unscheduled time
- Unused time slots time
- Scanner down time
- Preparation time

With a Philips Kaizen Event we can reduce five of these lowest-level time components. For these five, we constructed so called “Value Word Equations”. These equations allow us to conceptualize the potential time savings in a structured way. On the next pages we show the five equations with the results for UZ Brussel.

Equation 1: Net scan time reduction (mins):

Current net scan time - net scan time of top 10 performer

We advise adopting more efficient Examcards for spine, knee and ankle. We feel however that we can not advise these Examcards to academic hospitals since the purpose of MRI exams at academic hospitals is not only the diagnosis, but also training radiologists, visiting congresses and developing new scanning possibilities.

For this reason this equation is only applicable for non-academic healthcare facilities, and UZ Brussel can not realize any time savings in this area.

Equation 2: No-shows time reduction (mins):

if
- No-shows is between 5%-10% → [current no-shows-% - 5%] X [current exam duration]
- No-shows is >10% → [current no-shows-% - 10%] X [current exam duration]

We measured the number of no-shows for the month May. There were 65 no-shows out of 1,275 exams. That is 5.1% no-shows. Our no-shows prevention procedure can reduce the no-shows to approximately 5%. This means we can not realize any time savings here at UZ Brussel.

Equation 3: Unused time slots time (mins):

$$\Sigma(i) = \frac{[\text{current scheduled time for exam i} - (\text{gross scan time exam i} + \text{patientchangeover time exam i})]}{i}$$

For the most performed exams we recommend reconsidering the time slot used for scheduling the exam. The most performed exams are brain, spine and knee, together making up 70% of total exams.

We suggest adjusting the time slots to actual durations, which is gross scan time + patient-change-over time. The new time slots should be:

Exam	*Current time slot*	*Gross scan time*	*P.C.O. time*	*New time slot*
- Brain (33%):	30 mins	19:00 mins	5:45 mins	25:00 mins
- Spine (22%):	30 mins	17:00 mins	5:45 mins	20:00 mins
- Knee (14%):	30 mins	22:30 mins	5:45 mins	25:00 mins

Time savings: (0.33 x 5:00 mins) + (0.22 x 10:00 mins) + (0.14 x 5:00 mins) = 4:30 mins

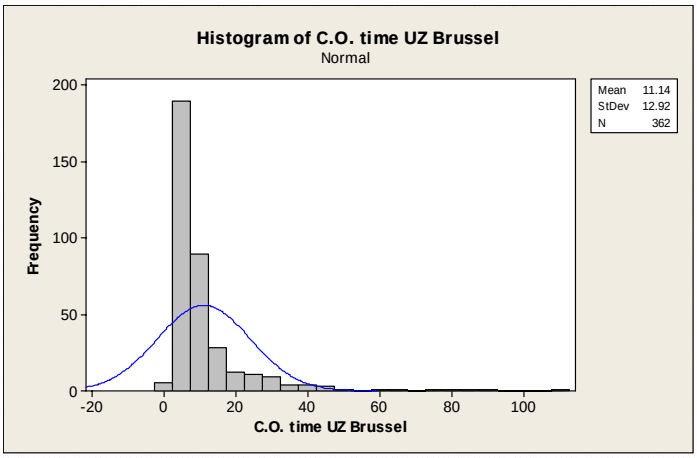
Equation 4: Unscheduled time reduction (mins):

$$\frac{\text{current unscheduled time per day} - 15\,\text{mins}}{\text{current average \# exams per day}}$$

The current scheduling system of UZ Brussel shows holes. This is because the current way of planning is not optimal. We analyzed the month May in 2009 and found that for UZ Brussel on average 35 minutes per day is unscheduled time. We can revise the planning system in such a way that UZ Brussel saves 45 seconds per exam with regard to this area.

VWE 5: Patient-change-over reduction (mins):

½σ of current patient-change-over time

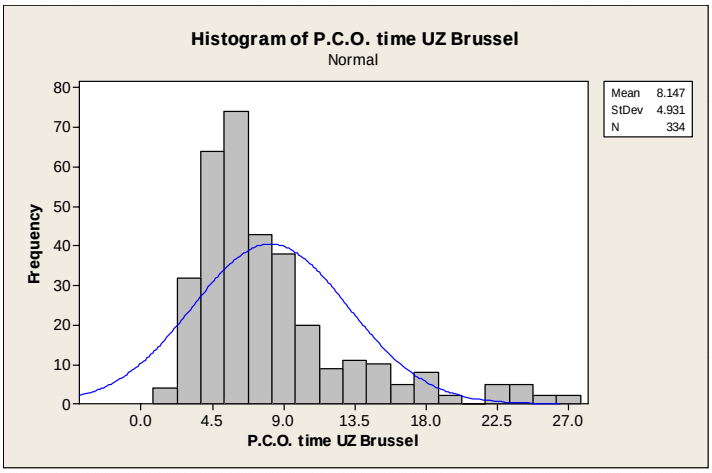


Descriptive Statistics: C.O. time UZ Brussel

Mean	11.136	StDev	12.919
Min	1.117	Max	109.933
Q1	5.012	Q3	10.712
IQR	5.700		

Currently for UZ Brussel the average change-over time is 11 minutes and 10 seconds. We retrieve this information from the Philips NetForum Database. The figure below displays the change-over time for UZ Brussel:

However, as we saw on page 5, patient-change-over is only a part of total change-over time. We can filter the patient-change-over time from above figure by deleting the outliers:



Descriptive Statistics: P.C.O. time UZ Brussel

Mean	8.147	StDev	4.931
Min	1.117	Max	27.183

With the Philips Kaizen Event we can reduce the patient-change-over time by ½σ. The time saving that can be realized here is 2:25 minutes. The new patient-change-time will be 5:45 minutes.

2. What the benefits are for UZ Brussel

We start with the monetary benefits of the Philips Kaizen Event. The Belgium reimbursement system does provide healthcare facilities with revenues for extra exams. The reimbursement differs per type of exam. We retrieved the reimbursement information from UZ Brussel. For the Pareto exams for UZ Brussel the reimbursements are:

Anatomy (+ frequency of occurrence)	*Reimbursement*
Brain (33%)	158,66 euro
Spine (22%)	158,66 euro
Knee (14%)	119,71 euro

For the other exams the reimbursement is on average 220 euro. Now we can calculate the monetary benefit from the Kaizen Event:

Average reimbursement for exam	(0.33 x 158,66 euro) + (0.22 x 158,66 euro) + (0.14 x 119,71 euro) + (0.31 x 220 euro) ≈ 170 euro
Extra number of exams per year	3,250 exams
Total monetary benefit	3,250 x 170 euro = 553,180 euro

Next to the monetary value, there is a social benefit, namely a reduction in access time for the patients. Access time is the time a patient has to wait for an MRI exam. Reducing this access time obviously has social value and will result in higher patient satisfaction.

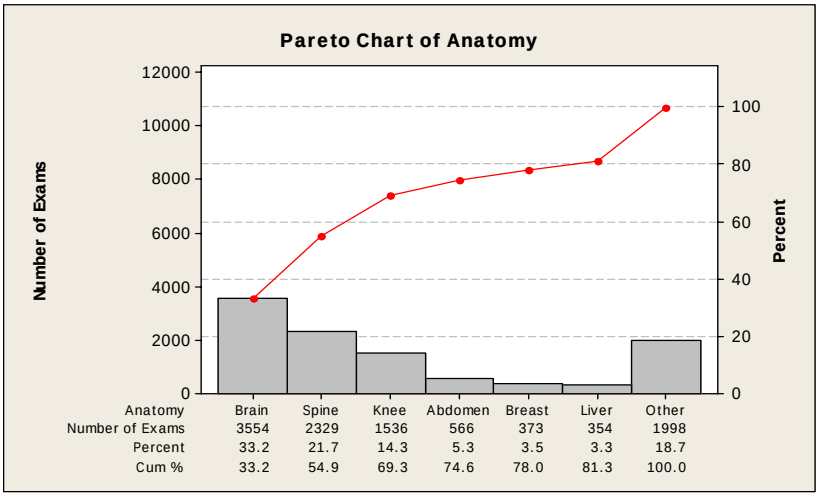
Furthermore, UZ Brussel will benefit from the Philips consultants because external advisors are perceived as more objective and more credible than internal advisors. This will result in an easier change and implementation process.

3. Cost implications

The figures (cost and number of examinations) used for the cost analysis are based on 2007 end of year financial report. The report is structured in the following way: section one discusses the Pareto of exams mix; the second section shows one (out of four) component cost computation. The third section presents the cost price of the six examinations; the fourth section shows the Volume-weighted average MRI examination cost; and the fifth section demonstrate the computation of incremental cost of MRI exams.

3.1 Pareto Chart of Examinations

The Pareto chart below shows that there are six popular examination types at UZ Brussel: brain, spine, knee, abdomen, breast and liver. Hence we compute the cost for each of them in our analysis and use these costs to compute the average MRI examination cost.



3.2 Examination Cost component Computation

We illustrate how we compute the radiologist cost component of each of the six anatomies. Our analysis is based on 4 fully qualified radiologists and 1 radiologist in training all working full time on MRI. Their total salary is € 722,325. Table 1 gives the summary of the results. The result indicates that abdomen examinations cost most (€ 27.77) in terms of radiologist costs and liver examinations are the least costly (€ 16.66). The results also show that out of the about 6,935 hours supplied, only 2,616 hours are used on clinical duties. The rest of the time is used for teaching, research and other things. We repeat similar computations for the technologist, MRI machine and the imaging room (these calculations are left out of this report).

Radiologist

	A	B = Hourly rate/60	C = A*B	D	E = A*D	F = C*D
Anatomy	Unit time (minute)	Rate per min	Cost driver rates	Volume	Specified time	Total cost assigned
Brain	18	€ 1.11	€ 20.00	3554	63972.00	€ 71,067.92
Spine	18	€ 1.11	€ 20.00	2329	41922.00	€ 46,572.08
Knee	16	€ 1.11	€ 17.77	1536	24576.00	€ 27,302.03
Abdomen	25	€ 1.11	€ 27.77	566	14150.00	€ 15,719.55
Breast	19	€ 1.11	€ 21.11	373	7087.00	€ 7,873.11
Lever	15	€ 1.11	€ 16.66	354	5310.00	€ 5,899.00
Total used					2616.95	€ 174,433.68
Total supplied					6935.50	€ 577,860.16
Unused capacity					4318.55	€ 403,426.48

Salary for radiologists is	€	722,325.20	
Radiologist works		8669.376	((1.08+4.11)*261*8hrs)
Hourly rate	€	66.66	

Table 1: Radiologist cost component of MRI Examination

3.3 MRI Examination Costs of the Six Anatomies

Table 2 presents the total cost of the six anatomies under consideration. The result indicates that knee examination is the cheapest (€ 127) approximately and the most costly is abdomen examination of € 167 approximately. Using this range of anatomy costs, we compute the ***volume weighted average examination cost to be approximately € 144***. The figures mentioned here appear in the table in purple colour.

Time-Driven ABC Model for MRI Examinations

	A	B	C	D	E = A+B+C+D	F	G = F*E	H = (Gi / ∑ Gi)*1	I = (Gi / ∑ Gi)*2	J = (Gi / ∑ Gi)*3	K = (G+H+I+J)/F
Anatomy	Radiologitst	Technologist	MRI Machine	Imaging room	Cost driver rates	Number of Examinations	Total Direct Cost Assigned	Variable cost*	Departmental Overhead Allocated	Hospital Overhead Allocated	Cost Per Examination
Brain	€ 20.00	€ 17.90	€ 23.23	€ 4.21	€ 65.32	3554.00	€ 232,162.51	€ 13,101.08	€ 157,089.20	€ 97,259.28	€ 140.58
Spine	€ 20.00	€ 16.68	€ 20.92	€ 3.84	€ 61.44	2329.00	€ 143,094.14	€ 8,585.37	€ 96,822.46	€ 59,946.08	€ 132.44
Knee	€ 17.77	€ 14.45	€ 22.39	€ 4.04	€ 58.66	1536.00	€ 90,106.62	€ 5,662.14	€ 60,969.26	€ 37,748.15	€ 126.62
Abdomen	€ 27.77	€ 17.00	€ 28.29	€ 4.87	€ 77.94	566.00	€ 44,111.50	€ 2,086.44	€ 29,847.37	€ 18,479.52	€ 167.01
Breast	€ 21.11	€ 17.13	€ 26.94	€ 4.72	€ 69.91	373.00	€ 26,074.64	€ 1,374.99	€ 17,643.00	€ 10,923.39	€ 150.18
Lever	€ 16.66	€ 17.08	€ 29.66	€ 5.42	€ 68.82	354.00	€ 24,362.13	€ 1,304.95	€ 16,484.26	€ 10,205.97	€ 147.90
Total	€ 123.31	€ 100.23	€ 151.43	€ 27.11	€ 402.09	8712.00	€ 559,911.55	€ 32,114.96	€ 378,855.55	€ 234,562.39	€ 864.72
Avg. cost	€ 20.55	€ 16.71	€ 25.24	€ 4.52	€ 67.01						€ 144.12
Avg. time (Min)	18.50	34.96	20.92	22.40	96.78						
		[1] Total variable cost (supplies)			€ 32,114.96						
		[2] Total Departmental overhead			€ 378,855.55						
		[3] Total Hospital Overhead			€ 234,562.39						

The volume-weighted average cost of MRI exams is € 144.12

Table 2: Total cost of MRI examination of the six Anatomies

3.4 Volume-Weighted Average MRI Examination Cost

From table 2, we computed the average cost of MRI examination to be approximately € 144. We show the break down of this average cost in table 3 below. The calculations show that the fixed departmental cost component forms about 25% of the cost. We based this computation on the assumption that 80% of the departmental overhead is fixed while the rest 20% is variable. In total, about 91% of the average MRI cost is fixed while only 9% is variable. This variable cost component is what goes into the incremental cost calculations.

INCREMENTAL COST ANALYSIS

Composition of volume-weighted MRI cost

Fixed Cost		Cost	Percentage
Radiologist Salary & Benefits	€	20.55	14.26%
Technologist Salary & Benefits	€	16.71	11.59%
Machine	€	25.24	17.51%
MRI Room	€	4.52	3.14%
Fixed Departmental Overhead	€	36.28	25.17%
Hospital Overhead	€	28.07	19.48%
Sub-total	€	131.36	91.15%
Variable Cost			
Supplies and other materials	€	3.69	2.56%
Variable Deparmental Overhead	€	9.07	6.29%
Sub-total	€	12.76	8.85%
Total	€	144.12	100.00%

Table 3: Break down of the Volume-weighted Average MRI Examination

3.5 MRI Incremental Cost Analysis

The incremental cost of MRI examination at UZ-Brussels is approximately € 12 (about 9% of the total cost) from the purple shaded row in table 3. The analysis of the value model shows that the Kaizen event is able to generate extra 3,254 examinations per year. Hence the incremental cost of these examinations is € 41,521 (€ 12.76*3,254). This is the figure shown in the other report as incremental cost. This cost together with the cost of hiring additional radiologist would be the total incremental cost of the extra examinations generated by the Kaizen events service.

4. Feedback Section

In our analysis, we made a couple of assumptions. We kindly ask you to provide us with your views on the following issues:

- Our analysis in table 1 shows that radiologists work only about 38% of the time on MRI examinations (clinical). Do you agree with this based on the time estimates in column two of table 1?
- Is the method followed in computing these figures clear enough?
- In your estimation, are the cost figures reported realistic?
- Does the understanding of the cost implications of Kaizen Events consulting service help you in assessing the usefulness of the service?
- What is your opinion on the benefits that we mention in section 2? Do you agree? Would you know any other benefits?
- Do any questions pop up when reading the Value Word Equations? (pg 6-8)
- Overall, how convincing is this value proposition to you?

Appendix J: Value creation and benefits for "Institute für Radiologie Kapfenberg, Austria"

Value creation and benefits of a Kaizen Event

For Institut für Radiologische Spezialdiagnostik Kapfenberg

Dear dr. Sulzer,

In front of you lies the document that describes how value was created and what the benefits are for your institute of the Kaizen Event conducted in March 2009. The findings are based on the Philips NetForum Data and our visit to your institute, on the 9th and 10th of July 2009.

Our intentions are to show you how Philips created value with the Kaizen Event that was conducted and what the benefits are for your institute.

We hope you enjoy reading this document. We would appreciate it if you can give us feedback on our proposal. For example, if particular issues are unclear to you, figures are incorrect, or simply if you question some conclusions we make.

We thank you for giving us all required information and for cooperating in the case study.

Best regards,

Marcel van Viegen

Trainee MRI Kaizen Events
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*"Because of the Philips Kaizen Event your MRI institute went from top 25 to **top 10 worldwide**"*

Summary

On the 9th and 10th of July 2009 we visited your institute with the purpose of finding out how you benefited from the Kaizen Event at March 2009. To find this out we have two tools, namely a value model and cost model developed by Philips. These models explain how value is created with a Kaizen Event and what the benefits are for your institute with consideration of the cost implications.

The past average exam duration was 18 minutes. Philips realized improvements in the MRI scanning process so that exam duration is reduced to approximately 17 minutes. We did this by improving the no-shows procedure and improving the patient-change-over procedure.

The improvements lead to roughly 505 extra MRI exams per year. Our value model shows the benefits for your institute of these increased exams. The Austrian reimbursement system does provide healthcare facilities with revenues for extra exams. The reimbursement differs per type of exam and decreases after 3,000 and 8,000 conducted exams. We calculated that the average reimbursement for an MRI exam when the boundary of 8,000 exams is exceeded is roughly 60 euro. This amount multiplied by the 505 extra exams results in a monetary benefit of € 30,300 in the first year.

Next to the monetary value, there is a social benefit, namely a reduction in access time for the patients. Furthermore, your institute benefited from the Philips consultants because external advisor are perceived as more objective and more credible than internal advisors. This resulted in an easier change and implementation process.

The extra exams also cause costs to increase. We calculated the incremental cost for an extra exam to be € 18.47. Multiplied by the 505 extra exams, this leads to € 9,325.- extra costs per year. The time spent by the institute staff during the Kaizen Event was estimated to cost an additional € 1,625.-.

Contents

1. How we created value

We start with explaining how we created value with the Philips Kaizen Event. We did this by reducing exam duration. In order to reduce exam duration, we have to understand exam duration. For that reason we split exam duration up into lowest-level time components which individually we can understand and measure.

Exam duration consists of two sequential steps: (1) gross scan time, and (2) change-over time. After delving deeper in these steps we identified in total eight different low-level times:

(1) Gross scan time
- Net scan time
- In-between-protocol-time

(2) Change-over time
- Patient-change-over time
- No-shows time
- Unscheduled time
- Unused time slots time
- Scanner down time
- Preparation time

With the Philips Kaizen Event we reduced five of these lowest-level time components. For these five, we constructed so called “Value Word Equations”. These equations allow us to conceptualize the realized time savings in a structured way. The equations apply to the following five time saving areas: (1) net scan time, (2) no-shows time, (3) unused time slots time, (4) unscheduled time, (5) patient-change-over time. On the next pages we show how the 1 minute reduction in exam duration can be allocated to some of these time savings areas.

We now allocate the 1 minute back to the Value Word Equations, based on the given recommendations by the Kaizen consultants. The main recommendations were:

- *Reduce patient-change-over* by better technologist/technologist and technologist/radiologist collaboration
- *Reduce no-shows* by reminder calls for first three patients of the day

Both patient-change-over time and no-shows time are part of change-over time. Next we plot the change-over times before and after the Kaizen Event. Then we can filter patient-change-over times before and after the Kaizen Event. This analysis allows us to find out how much patient-change-over time has been reduced, and also how much no-shows time has been reduced since that is the complement of the time savings.

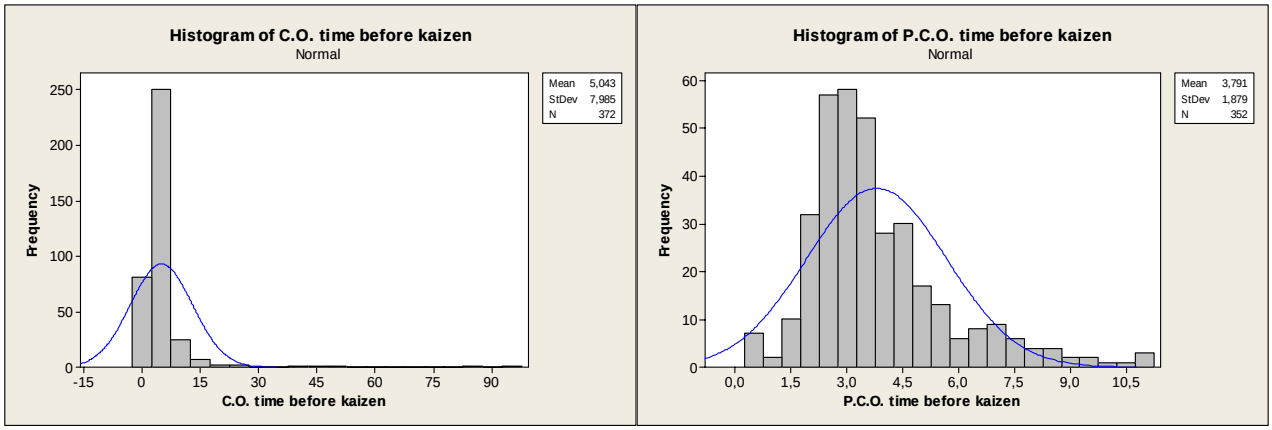


Figure 1: Change-over time and patient-change-over time before Kaizen Event

The left hand side of Figure 1 shows that change-over time was 5:00 mins. All times within change-over time are inefficiencies expect patient-change-over time. We can remove inefficiencies from the data by performing an outlier analysis. If we remove all outliers from the change-over time distribution, we should be left with only the patient-change-over times. The outlier analysis we perform is the inter-quartile-range (IQR) analysis. This means we define the values Q1-(3*IQR) and Q3+(3*IQR) as outliers, where Q1 is the first quartile, Q3 is the third quartile, and IQR is the range between the first and the third quartile. The right hand side of Figure 1 now shows the patient-change-over time, which was 3:50 mins.

We retrieved the same data sets from Philips NetForum but then four months after the Kaizen Event (July 2009). Next we plot these new change-over times and new patient-change-over times:

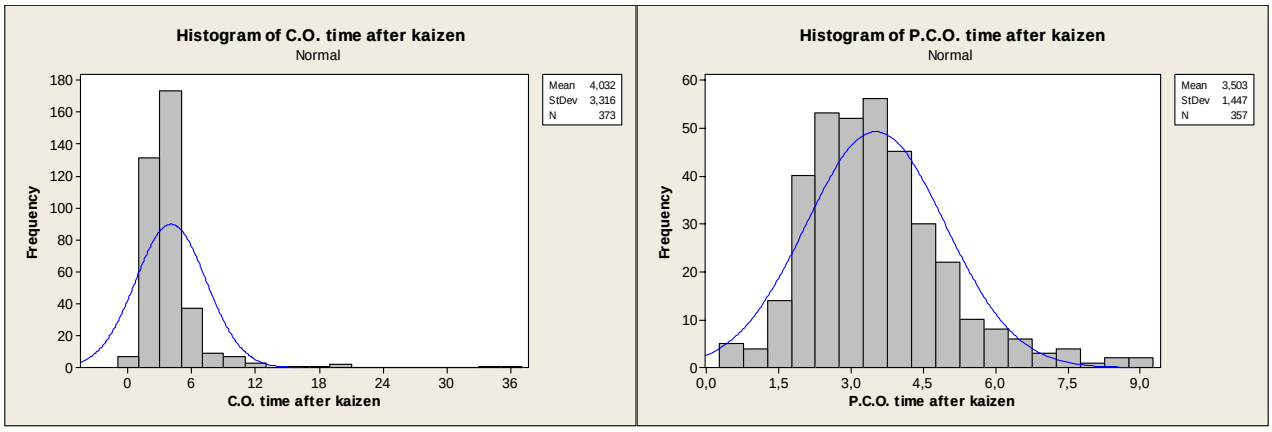


Figure 2: Change-over time and patient-change-over time after Kaizen Event

Figure 2 shows that change-over time now is 4:00 mins. This result is exactly as expected, since we measure that total time savings are 1 minute and stated that this can in total be allocated to change-over time considering the recommendations given by the Kaizen consultants. Figure 2 also shows that patient-change-over time now is 3:30 mins. This analysis shows us that patient-change-over time has been reduced by 20 seconds. Total time savings are 1 minute, so the remaining 40 seconds time savings can be allocated to the other improvements, which in this case was no-shows reduction.

Although the Kaizen Event has already been done, we can still fill in the Value Word Equations. The only difference is that the actual time savings are known in stead of educated guesses. The Value Word Equations are:

Net scan time reduction:	0:00 mins
No-shows time reduction:	0:40 mins
Unused time slots time reduction:	0:00 mins
Unscheduled time reduction:	0:00 mins
Patient-change-over time reduction:	0:20 mins
Total	**1:00 mins**

2. What the benefits are for MRI Institute Kapfenberg

We start with the monetary benefits of the Philips Kaizen Event. The Austrian reimbursement system does provide healthcare facilities with revenues for extra exams. The reimbursement differs per type of exam. We retrieved the reimbursement information from MRI Institute Kapfenberg. For the Pareto exams, after 8,000 exams have been conducted the reimbursements are:

Anatomy (+ frequency of occurrence)	*Reimbursement*
Knee (33%)	50.00 euro
Spine (18%)	50.00 euro
Brain (16%)	70.00 euro
Shoulder (10%)	70.00 euro

For the other exams the reimbursement is on average 70 euro. Now we can calculate the monetary benefit from the Kaizen Event:

Average reimbursement for exam	(0.33 x 50 euro) + (0.18 x 50 euro) + (0.16 x 70 euro) + (0.10 x 70 euro) + (0.23 x 70 euro) ≈ 60 euro
Extra number of exams per year	505 exams
Total monetary benefit	505 x 60 euro = 30,300 euro

Next to the monetary value, there is a social benefit, namely a reduction in access time for the patients. Access time is the time a patient has to wait for an MRI exam. Reducing this access time obviously has social value and will result in higher patient satisfaction.

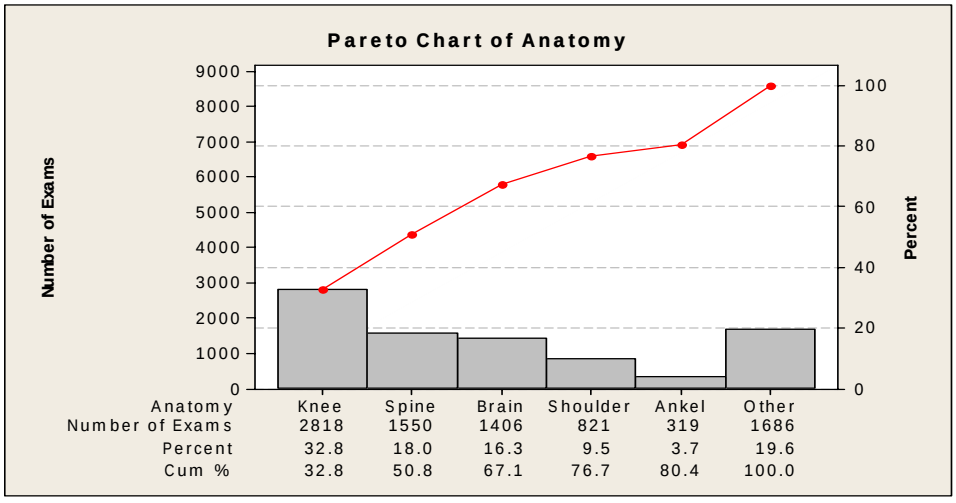
Thirdly, there is the benefit from the Philips consultants because external advisors are perceived as more objective and more credible than internal advisors. This resulted in an easier change and implementation process.

3. Cost implications

The figures (cost and number of examinations) used for the cost analysis are based on 2008 end of year financial report. The report is structured in the following way: section one discusses the Pareto of exams mix; the second section shows one (out of four) component cost computation. The third section presents the cost price of the five examinations; the fourth section shows the Volume-weighted average MRI examination cost; and the fifth section demonstrate the computation of incremental cost of MRI exams.

3.1 Pareto Chart of Examinations

The Pareto chart below shows the examinations conducted in 2008. The figure shows that there are five popular examination types at Institut Fur Rad. Spezialdiagnostik: knee, spine, brain, shoulder and ankle. These figures were based on projections from Philips. We compute the cost for each of them in our analysis and use these costs to compute the average MRI examination.



3.2 Examination Cost component Computation

We demonstrate how we calculate the radiologist cost component of each of the five anatomies. Our analysis is based on 4 fully qualified radiologists with total salary of € 470,000. The summary of the results is shown in table 1. The result indicates that both brain and ankle examinations cost the same (€ 8.79) in terms of radiologist costs. Spine examinations are the least costly (€ 5.02). The results also show that out of the about 3,993 hours supplied, only 607 hours are used on clinical MRI duties. We repeat similar computations for the technologist, MRI machine and the imaging room (these calculations are left out of this report).

Radiologist

	A	B = Hourly rate/60	C = A*B	D	E = A*D	F = C*D
Anatomy	Unit time (minute)	Rate per min	Cost driver rates	Volume	Specified time	Total cost assigned
Knee	5	€ 1.26	€ 6.28	2818	14090.00	€ 17,687.77
Spine	4	€ 1.26	€ 5.02	1550	6200.00	€ 7,783.12
Brain	7	€ 1.26	€ 8.79	1406	9842.00	€ 12,355.07
Shoulder	5	€ 1.26	€ 6.28	821	4105.00	€ 5,153.18
Ankel	7	€ 1.26	€ 8.79	319	2233.00	€ 2,803.18
Total used					607.83	€ 45,782.32
Total supplied					3993.60	€ 376,000.00
Unused capacity					3385.77	€ 330,217.68

Assume salary for radiologist is	€	470,000.00	
Radiologist works		4992	(30hrs52wks*4fte*0.8)
Hourly rate	€	75.32	

Table 1: Radiologist cost component of MRI Examination

3.3 MRI Examination Costs of the Five Anatomies

Table 2 on the next sheet presents the total cost of the five anatomies under consideration. The result shows that spine examination is the cheapest (€ 83) approximately and the most costly is brain examination of € 116 approximately. Using this range of anatomy costs, we compute ***the volume weighted average examination cost to be approximately € 92***. The figures mentioned here appear in the table in purple colour.

Time-Driven ABC

	A	B	C	D	E = A+B+C+D	F	G = F*E	H = (Fi / ∑ Fi)*1	I = (Gi / ∑ Gi)*2	J = (G+H+I)/F
Anatomy	Radiologitst	Technologist	MRI Machine	Imaging room	Cost driver rates	Number of Examinations	Total Direct Cost Assigned	Variable cost	Departmental Overhead Allocated	Cost Per Examination
Knee	€ 6.28	€ 9.34	€ 14.59	€ 1.99	€ 32.20	2818.00	€ 90,747.08	€ 24,658.52	€ 126,564.70	€ 85.87
Spine	€ 5.02	€ 10.71	€ 13.70	€ 1.71	€ 31.14	1550.00	€ 48,272.59	€ 13,563.06	€ 67,325.65	€ 83.33
Brain	€ 8.79	€ 13.03	€ 20.27	€ 2.51	€ 44.60	1406.00	€ 62,709.11	€ 12,303.01	€ 87,460.22	€ 115.56
Shoulder	€ 6.28	€ 9.90	€ 14.55	€ 1.80	€ 32.53	821.00	€ 26,708.59	€ 7,184.05	€ 37,250.40	€ 86.65
Ankel	€ 8.79	€ 9.46	€ 13.61	€ 1.92	€ 33.78	319.00	€ 10,775.84	€ 2,791.37	€ 15,029.04	€ 89.64
Total	€ 35.15	€ 52.44	€ 76.73	€ 9.94	€ 174.26	6914.00	€ 239,213.22	€ 60,500.00	€ 333,630.00	€ 461.05
Avg. cost	€ 7.03	€ 10.49	€ 15.35	€ 1.99	€ 34.85					€ 92.21
Avg. time (Min)	5.60	16.99	11.65	13.28	47.52					
		1 Total variable cost (supplies)			€ 60,500.00					
		2 Total Departmental overhead			€ 333,630.00					

The volume-weighted average cost of MRI exams is € 92

Table 2: Total cost of MRI examination of the five Anatomies

3.4 Volume-Weighted Average MRI Examination Cost

From table 2, we computed the average cost of MRI examination to be approximately € 92. We show the break down of this average cost in table 3 below. The calculations show that the fixed departmental cost component forms about 42% of the cost. We based this computation on the assumption that 80% of the departmental overhead is fixed while the rest 20% is variable. In total, about 80% of the average MRI cost is fixed while only 20% is variable. This variable cost component is what goes into the incremental cost calculations.

Composition of volume-weighted MRI cost

Fixed Cost	Cost		Percentage
Radiologist Salary & Benefits	€	7.03	7.62%
Technologist Salary & Benefits	€	10.49	11.38%
MRI Machine	€	15.35	16.64%
Imaging room	€	1.99	2.16%
Fixed Departmental Overhead	€	38.89	42.17%
Sub-total	€	73.74	79.97%
Variable Cost			
Supplies and other materials	€	8.75	9.49%
Variable Departmental Overhead	€	9.72	10.54%
Sub-total	€	18.47	20.03%
Total	€	92.21	100.00%

Table 3: Break down of the Volume-weighted Average MRI Examination

3.5 MRI Incremental Cost Analysis

The incremental cost of MRI examination at Institut Fur Rad. Spezialdiagnostik is approximately € 18 (about 20% of the total cost) from the purple shaded row in table 3. The analysis of the value model shows that the Kaizen event is able to generate extra 505 examinations per year. Hence the incremental cost of these examinations is € 9,327 (€ 18.47*505). This cost together with the cost of hiring

additional radiologist would be the total incremental cost of the extra examinations generated by the Kaizen events service.

4. Feedback section

In our analysis, we made a couple of assumptions. We kindly ask you to provide us with your views on the following issues:

- Our analysis in table 1 shows that radiologists work only about 607 hours out of the available 3,993 hours per year on MRI examinations (clinical). Do you agree with this based on the time estimates in column two of table 1?
- What percentage of radiologist time is spent on MRI examinations?
- What percentage of technologist time is spent on MRI examinations?
- Is the method followed in computing these figures clear enough?
- In your estimation, are the cost figures reported realistic?
- What is your opinion on the benefits that we mention in section 2? Do you agree? Would you know any other benefits?
- Overall, how convincing is this value creation report to you?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