Spaarne ZIEKENHUIS | Delft TopTech School of Executive Education

Balanced Scorecard Tower: A framework for comparing IT investment against business benefits

Master in IT Management - Thesis

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Management Summary

This thesis contains the result into the research of systematic measurement of business benefits from an investment in IT. Research into this topic has originated from a case study where insight was required into the return on IT investment in a patient logistic application.

Providing evidence of business benefit and therefore productivity from an investment in IT has been an ongoing challenge over a number of years. A lack of evidence of an expected increase in productivity from an increase in IT investment is commonly known as the productivity paradox.

Healthcare and an IT investment in healthcare are topics that are increasingly important in both the business and scientific worlds. Therefore the ability to systematically provide evidence of business benefit from an IT investment will not decrease in importance in the future. Providing insight into the business benefits from an IT investment will be beneficial for strategic investment and operational effectiveness.

Our approach has been to explore the healthcare domain and the theoretical domain of performance measurement. We required an existing model that could be directly used for correlating strategy with operations and for defining and measuring the necessary variables so that evidence of an improvement in business benefits could be regularly and systematically provided. Unfortunately, we found no such model that exists. We have therefore created a new framework, the BSC Tower to address this problem.

The BSC Tower provides a framework for measuring and moving between strategic, tactical and operational levels. At the strategic level the IT investment is correlated against the different types of business benefits expected. Moving down to the tactical level the strategic investment and business benefits are translated to their operational variables. The next step is to measure these variables in the operational level. Measurements of these variables at predetermined intervals provide insight into the improvement of these variables and therefore the business benefits. Correlating investment variables against business benefits provides insight into the effectiveness of the investment. Correlating strategy against the operational results provides insight into the mismatch and potential for improvement in both strategy and operations.

Our BSC Tower has been verified against our own test data and validated by our case study sponsor. The result is that the BSC Tower is feasible as a solution for the case study and it does represent existing theory. There are challenges for the BSC Tower due to the potentially vast amount of data that needs to be filtered. Further research and a pilot supported by a business intelligence approach would be useful as an exercise to further refine and validate the BSC Tower and hopefully provide insight into costs and benefits in the important area of healthcare.

Keywords

Healthcare, patient logistics, productivity paradox, IT investment, business benefits.

Preface

This master thesis is the product of research we have conducted between October 2008 and May 2009 with the help of Spaarne hospital in the Netherlands. The focus of our research has been the introduction of a patient logistic application and a way of providing evidence of healthcare benefits from investment in this application. Increase in productivity, as represented by the productivity paradox, by investing in IT is difficult to measure. Effective productivity, by investing in new IT due to a lack of capability in existing IT, is also difficult to measure. This does not mean that measurement should not be performed. Our research is based on providing a basis whereby evidence of productivity, in the form of business benefits from an investment in IT, can be provided.

Providing this evidence is not easy because it requires the systematic and continual measurement and correlation between tangible and intangible variables. Tangible variables are quantifiable, for example, incoming and outgoing cash-flow. Intangible variable are not immediately quantifiable because they are, for example, very much related to subjective opinion. The difficulty of our research has been therefore to provide a way of combining these different types of variables into the same framework.

Being a working parent has also put pressure on time management of work, family and thesis. Recognising the type of person one is and accepting this as part of the way of working has also been difficult because after the initial set of interviews and literature research it was clear that a gap in existing theory had to be filled. This gap had to be filled by creating a framework from reading, understanding and filtering from what was available in theory and validating this information against interview results and the case study documentation. Different versions of the results of this process have been improved with significant help from my supervisor in the Technical University, Delft – Jan van den Berg. I would like to take this opportunity to sincerely thank my sponsor, Yvonne Wilders, Raad van Bestuur, and her colleague, Andrea Lambrichs-de Bruin, for allowing me to use Spaarne hospital as a case study and providing me with time and access to relevant information and personnel within Spaarne.

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1 Introduction

This introductory chapter provides an explanation of the background and motivation for our thesis. Following on the problem description and research questions are stated and explained. Finally, the method used to answer our research questions together with the scope of our research is explained in order to provide a guide and context of this research.

1.1 Background

This thesis has been motivated by two related topics. One is based on the requirement to find a real-world problem to research and report on this research as part of the Master of IT Management course, Technical University in Delft, Holland. A real-world problem of correlating IT investment and business benefits is described in the next section. Our next topic, the productivity paradox, was found after initial background research on the real-world problem.

Two fundamental questions (Brynjolfsson and Yang 1996) are related to productivity paradox; (i) Why would companies invest so heavily in information technology if it didn't add to productivity? (ii) If information technology is contributing to technology, why is it so difficult to measure it? Our intention is not to answer these questions. Our motivation is to find out if it is possible to provide insight into return on investment in business from IT investment and describe and justify a way to achieve this by using a real-world example that is experiencing the real-world problem.

Research going back more than 20 years has highlighted conflicting and confusing results for correlating an investment in IT with business productivity. Research in the 1980's supports the argument that an annual increase in IT investment cannot be justified because of the lack of evidence directly relating IT investment with business benefits. There is research from the early 1990's that shows it is possible to see evidence of a business benefit payback from IT investment, but only after a time lag where the end-user organization has learned to use IT to its full potential. (Brynjolfsson and Yang 1996). Some research does conclude that it is impossible to provide direct evidence of business benefit payback from IT investment.

If IT investment can be correlated with the resulting business performance it must be possible to achieve this in a systematic and structured way. Repeating this approach will provide a mechanism for; comparing actual benefits against those expected and measuring improvements over time. An insight into return on investment and payback period is a result of these measurements.

1.2 Research

1.2.1 Problem description

Spaarne "*ziekenhuis*", a hospital in the Hoofddorp area between Amsterdam and Haarlem, have invested in a new patient logistic application because of the requirement to improve the logistics of the patient treatment process and the digitalization (improvement of electronically available information) of the hospital. The existing system did not provide an integrated logistical solution and it did not conform to the user requirements and government health law (Bruin 2008). A decision was made to invest in an application that answered these requirements and was flexible for planned changes in the near future. A phased approach was used to introduce the new application in different releases to make it easier to keep the "shop open" and phase out the existing solution and consequently minimize the effect on the end-user organization.

The "*Raad van Bestuur*" (the hospital board) needed to know that their IT investment in this new application was paid back by the benefits to the hospital. In an interview our sponsor stated the investment had to be justified because it was a significant part of the hospital budget and the application needed to support the hospital strategy towards a more efficient patient centric process for some years into the future.

At the onset of this research the first phase of introducing the new application was complete. *The problem is that, in spite of a lot of individual knowledge about the benefits, there is no mechanism for systematically providing evidence that the investment has been paid back by the application's use in the hospital.* If the application does not work or it is too ineffective in supporting business processes that must be supported or it is too inflexible for adaption to support new business processes in the future, together with existing processes, then the application will have failed its fit-for-purpose objective.

Evidence of this fit-for-purpose capability can only be provided by measurement and analysis of the necessary variables. We address the challenge of this problem by providing a measurement model framework that could be used by Spaarne and which could be adapted for other healthcare centres and for other business domains. We therefore do not intend to provide an all encompassing solution to this problem. Our research goal is to find or define such a measurement model framework that could be used as a basis for defining, measuring, analysing and reporting in a continual improvement organizational culture. This could facilitate a systematic approach to providing evidence of business benefit from IT investment.

1.2.2 Main research question

Our main research question follows directly from difficulties of matching IT investment with business productivity for the case study problem:

"What framework is appropriate for providing continual and systematic insight into the business benefits from an investment of IT?"

By framework we mean a basic system (1990) that can be used for measuring and comparing IT investment against business benefits. We deliberately use a generic approach because we want to reduce any negative effects on flexibility from a case study and we want to maximise flexibility for potential re-use outside the case study. With appropriate is meant a framework that is based on solid research that could be applied to a real-life situation.

The case study as described in section 1.2.1 has been used as a basis to design the framework and has been verified by test data and validated by our sponsor.

1.2.3 Research sub-questions

An answer to the main research question can only be provided by further sub-dividing this question into its main constituents as follows:

What are the recent developments within healthcare in Holland and Europe that are related to strategic investment in IT and the business benefits from its use?

Which performance measurement models can be used for correlating IT investment with business benefits?

Which framework can be used for correlating business benefits with IT investment in a healthcare case study?

To what extent is the chosen framework useful for correlating business benefits with the healthcare case study?

1.3 Scope of research

1.3.1 In scope

- A measurement model framework that has been validated by a case study healthcare expert. We restrict ourselves to IT and the interface provided by IT to its external actors.
- A personal critique and evaluation of the thesis. There will be strengths (hopefully) and weaknesses (definitely) in our research. Our perception is that this is part of a normal learning curve in the "making a thesis" process. Providing a personal critique and evaluation is an aid to crystallising and providing evidence on what has been learnt.
- Conclusions for useful follow on work with the framework in healthcare. A measurement model framework cannot be perfect but if it addresses the case study problem it could be possible to define both follow on work for the case study and additional follow on work for adapting the framework to healthcare in general.
- Conclusions for follow on work with the framework in business domains outside healthcare. There is a requirement to perform abstraction and generalize analysis from the research. A result of this is a framework that is not too specific and could potentially be extended for re-use outside healthcare.

1.3.2 Out of scope

- A complete business analysis of the case study and an attempt to measure the effectiveness of the business processes.
- A fully worked out measurement using the framework on the case study. Academic advice is that it would take too much time to gather real-world data to represent all variables in a framework. Focus should be on the academic aspects of the thesis. This might limit a real-world analysis of any framework but this could be addressed by advice on follow-on work as part of the conclusion.
- Strategic, tactical and operational decisions following on from the empirical use of the framework on the case study. These decisions are directly related to the gathering of real-world data because real-world data is required to make such decisions. They are not in scope because their context is one of use in a real-world scenario instead of our context which is academic research.
- Financial information of a sensitive nature has been provided with interviews of the case study organization. The case study financial department do not use activity based costing or total cost of ownership in their financial calculations. The contract for the patient logistics application is fixed price combining development and support over a number of years. Using, for example, activity based costing in the measurement model to simultaneously calculate costs over different departments is not feasible because this requires a change to the operational way of working. We have therefore restricted our modelling to a description of cost and income in abstract terms.

1.4 Research methodology

Figure 1 represents the method that has been used to answer the research questions.

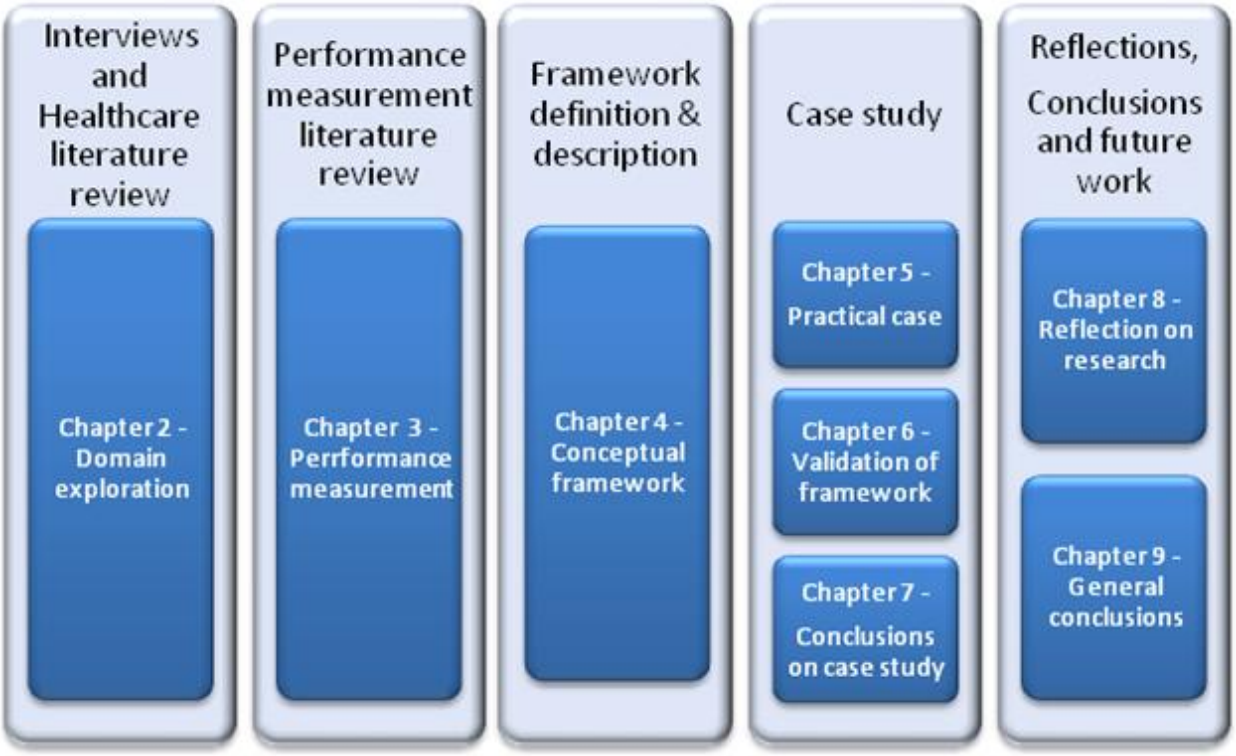


Figure 1 Research approach

Chapter 2 provides an answer to the first research sub-question by describing recent developments within healthcare both in Europe and Holland and for the case study in Spaarne. We expect our case study organization not to be working in isolation in its approach to IT and healthcare. Our first research sub-question helps to answer how consistent the future plans of our case study is with those equivalent in Holland and the rest of the European Community. This will provide us with more insight into the requirements on a framework and it will enable us to build in more flexibility into this framework in its potential re-use in other healthcare organizations.

Chapter 3 addresses the second research sub-question by describing performance measurement models against the requirements of our case study. This provides us with a reference on measurement models that can be used as a basis for defining our own framework.

The framework – our measurement model – is described in Chapter 4 and provides an answer to the third research sub-question. We use input from the first two sub-questions so that we can define and describe our framework.

Our use of the framework with *test data* is described in Chapter 5 together with a validation of this framework in chapter 6. Together these provide an answer to the fourth research sub-question.

Our conclusion on our research results is described in chapter 7. A reflection on what we have achieved and our ideas for further work are described in chapters 8 and 9.

2 Domain exploration

"What are the recent developments within healthcare in Holland and Europe that are related to strategic investment in IT and the business benefits from its use?"

This chapter provides a more detailed insight into the healthcare domain on which our research has been focused. We did not want to limit ourselves to documentation and interview results from Spaarne alone because this would ignore any external developments that are directly or indirectly related to the decision to invest in EPIC. A result of this would be an isolated, inflexible research that would be difficult to adapt in and outside Spaarne. We have addressed this point by researching the developments in the European Community, Holland and then, finally Spaarne.

Firstly section 2.1 describes current healthcare developments in the European Community and Holland. Section 2.2 then provides a background of our case study hospital. We then move into more detail in section 2.3 by describing the objectives of the case study and how these objectives relate to current European and Dutch developments.

2.1 Healthcare

2.1.1 Developments in the European Community

The European Community has reaffirmed the importance of health policy by stating that a new strategy for healthcare is required in Europe (23.10.2007). This strategy has to address the following issues. Firstly, democratic changes including population ageing and the resulting pressure on (European Union) EU health systems. Secondly, the security aspects related to global health threats such as new communicable diseases patterns as a result of climate change and potential bioterrorist threats. Thirdly, the rapid development of new technologies has revolutionized the way that healthcare is promoted and illness is predicted, prevented and treated. New technologies include information and communication technologies (ICT), innovation in genomics, biotechnology and nanotechnology. The resulting European community wide strategic objectives that follow are; (i) to foster good health in an ageing Europe, (ii) to protect citizens from health threats and (iii) to support dynamic health systems and new technologies. An additional issue is for the structural sharing of healthcare between member states (2.7.2008). EU citizens who travel between different EU countries need a standard quality of care.

As a result the EU are moving towards a "European eHealth area", eHealth being the overarching term for the range of ICT tools used to assist and enhance the prevention, diagnosis, treatment, monitoring, and management of health and lifestyle. The success of this venture requires that citizens', patients', and health professionals' requirements and involvement are considered in the implementation strategies and projects. eHealth is an integral component of the EU's i2010 (17.04.2008) policy framework which seeks to promote an open and competitive digital economy, ICT-related research, as well as applications to improve social inclusion, public services and quality of life. The European network for Health Technology Assessment (EUnetHTA) has been set up in 2006 to strengthen the link between healthcare policy and HTA in the European Union. Health technology assessment (HTA) is a multidisciplinary process that summarises information about the medical, social, economic and ethical issues related to the use

of a health technology in a systematic, transparent, unbiased and robust manner. Its aim is to inform the formulation of safe, effective, health policies that are patient focused and seek to achieve best value. Interestingly there is mention of ICT's support for a more effective healthcare at a European level but there is no mention of a SMART strategy for the effective measurement of ICT itself. ICT might be improving healthcare but this does not mean that ICT is totally efficient.

2.1.2 Developments in Holland

An initiative for improving the transparency, efficiency and quality of health care service has been introduced at a national level in 2003 by the Dutch Ministry of Health. The objective has not only been to provide institutional measures, such as regulated competition, but also by benchmarking and best practices in order to stimulate local innovations. The Ministry of Health have defined three priority schemes namely, patient safety, patient logistics and patient responsiveness. This Ministry has declared a more recent policy of a priority on quality and prevention in healthcare and innovation for the coming years (VWS 2008). This includes better measurement of quality, more insight into costs and less bureaucracy. The patient is central and there are less medical mistakes. A significant factor is that with a culture of government regulation of the private sector there are no strict legal requirements for a guarantee of the effectiveness and efficiency of ICT solutions or guidelines for measurements to provide this evidence.

Current developments within Dutch Healthcare require that patients and healthcare professionals are electronically registered and recognized by their own unique pass. For patients this is their BSN card and for healthcare professionals this is their UZI pass. The use of the BSN pass in healthcare institutions is required by law from June 2009. Patient medical details are planned to be shareable at a nationwide network level through the use of an Electronic Patient Record (EPR) and the underlying database and network. Currently the introduction of the EPR, which was planned to be introduced in September 2009, has been delayed for an indeterminate period due to logistic and organizational problems of role based access to patient details. Role based access is a result of the BSN law stating that healthcare professionals will only have access to a patient's medical record if the patient allows them to have access.

2.2 Healthcare in Spaarne

The Spaarne hospital is a top clinical teaching hospital with approximately 2000 employees of which 1200 are medical specialists. The headquarters is located in Hoofddorp and provides 455 hospital beds. Almost all medical specialism is represented in this new, easily accessible and excellently equipped hospital. An outpatient facility is provided in Heemstede.

Every year about 17,000 patients are admitted, with about 11,000 day treatments and 300,000 outpatient visits. The patients mainly come from the nearby councils, Haarlemmermeer, Heemstede, Haarlem-Zuid, Zandvoort, Bloemendaal/Aerdenhout, Vogelenzang and Bennebroek. The population in these councils are ageing. Spaarne Hospital provides medical specialist education which is based on the ambition to further its profile as a teaching hospital. The motto of Spaarne is *'Specialisten in mensenwerk'* which means that it provides specialism focussed on people. This motto is the basis for every activity within the hospital.

The European and Dutch developments that are affecting Spaarne are the resulting laws for unique identification of patients and healthcare officials in a location independent network of hospitals with an underlying information network.

Spaarne is currently implementing a patient logistics application to address these requirements. This application has an installed base of one in four of all medical hospitals in the United States. It is being implemented into the existing Spaarne organization in three phases of which the first phase has been live since January 2008. Phase 2 is planned to go live in April 2009.

2.3 Patient logistics

EPIC provides an integrated patient care treatment path and it does support the BSN requirement. It has been chosen for its flexibility to adapt to changes in user requirements, such as an ageing population, and changes in the Dutch law related to healthcare. The strategy of Spaarne to use EPIC maps directly to the healthcare developments at a European level as mentioned in section 2.1.1 and at a national level as mentioned in section 2.1.2.

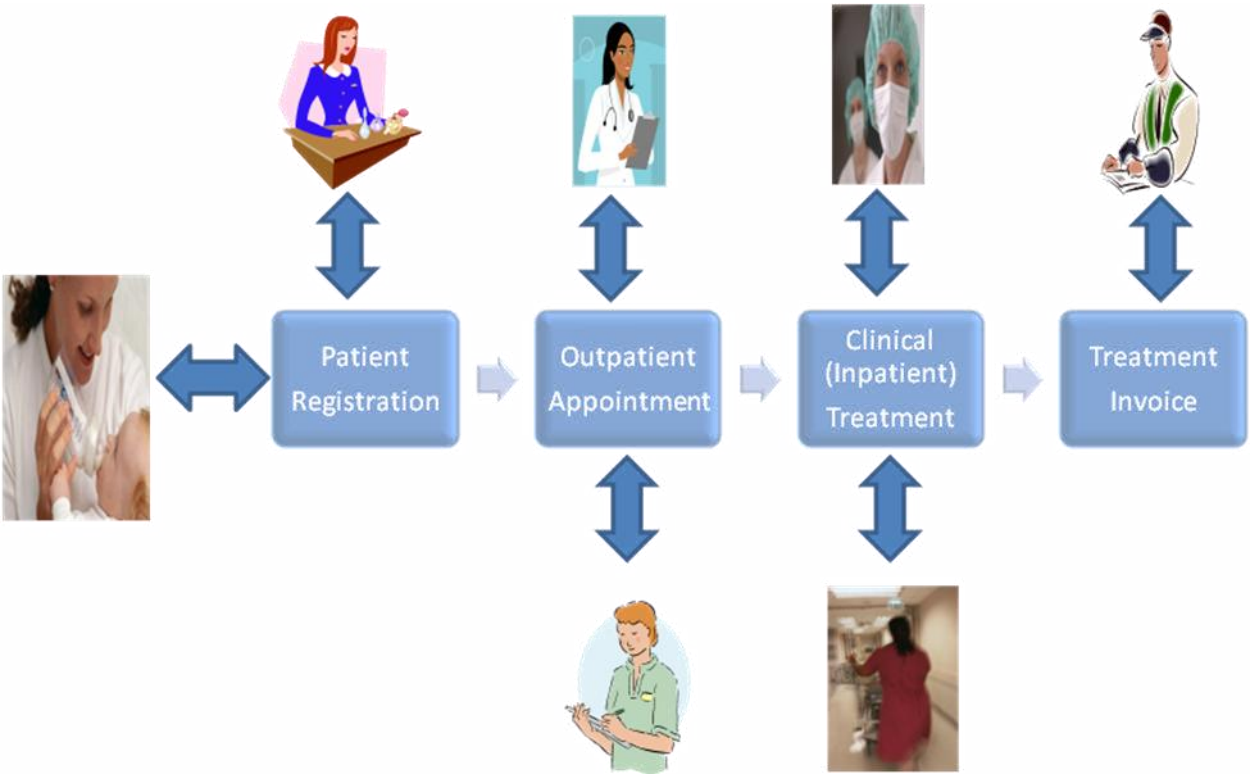


Figure 2 Patient care

This thesis is focussed on the improvement of the patient logistics by measuring the efficiency of the patient treatment chain. Figure 2 represents a (simplified) patient logistic treatment example whereby a patient needing treatment has been referred for a hospital appointment by their general practitioner (GP). The patient must first register their presence at a central reception where their identification is checked and they are provided with an identity card for further use. They are directed to the outpatient department where they are initially questioned and assessed by a nurse followed by a medical assessment by a doctor. The assessment is registered in the form of a DBC

which defines both the diagnosis followed by the required course of treatment. An appointment is made for the specific medical or surgical treatment at a later date. The patient returns on the specified date and undergoes the necessary medical or surgical treatment and after recovery is allowed to go home. Before going home an appointment is made for the patient to go back to the hospital for a health check. The patient returns to the hospital and goes directly to the necessary outpatient department where they are assessed for full recovery. After a confirmation of total recovery the treatment (DBC) chain is closed and the patient does not have to return to the hospital. The closure of the treatment chain allows the hospital to bill the patient's insurance company or the patient directly for the treatment.

There are exceptions to this simple example such as treatment of chronic health where a full recovery from an ailment is not possible and emergency treatment. In principle the basic process is the same except that there is no visit to the outpatients.

We now have a basis for investigating what exactly we should be measuring and what are the available models for performing these measurements. These topics are addressed in the next chapter.

3 Performance measurement

Which performance measurement models can be used for correlating IT investment with business benefits?

This chapter follows on from the exploration into the healthcare domain explained in the previous chapter by analyzing models that are most appropriate to our case study. Reasoning behind this is that we need to decide on the best models to use so that we can measure business benefits against IT investment in EPIC, the patient logistics application. Appendix B provides extra reference information on the models that we have selected including a model selection matrix. Appendix C lists the models that we have rejected and justifies why we have rejected them.

We provide first in section 3.1 a description of the changes within our case study and the drivers that are affecting these changes. This information has been obtained from interviews that are documented in Appendix G. Section 3.2 continues by explaining what we think needs to be measured and when these measurements should be performed. In section 3.3, we summarize our review of the appropriate literature on the match between IT investment and business benefits. Models that are most fit for our purpose are described in section 3.4. Content in this chapter therefore defines input for the definition of our measurement model and its use on the case study. Our approach is to structure our findings so that the requirements on a measurement model are relevant to our case study, to changes in the case study and re-use both inside healthcare and in other business domains.

3.1 What is the change?

Figure 3 represents a typical ("As Is") scenario within healthcare in Holland that is consistent with people, processes and IT working together. Departments work as separate process islands on the same patient with the medical staff at the centre of each treatment chain. Communication and information sharing within the organization is inefficient because steps in the treatment work flow involve a partial duplication of information processing and therefore effort. IT enables information storage and retrieval but does not enable the total work flow for each treatment chain instance to be optimally efficient. Both IT and the hospital processes are costs. Income is generated from the completed treatment of patients.

The end of a treatment chain instance triggers the payment for the treatment. Type of treatment determines the amount to be charged. Approximately 70% of all treatments have a fixed charge. The remaining 30% are negotiable between the health sector and the insurance bodies. A Dutch government objective is to achieve 60% negotiable treatment charges by 2010. This implies a significant improvement in flexibility with respect to executing and measuring the results of treatment paths. Negotiable demand on double the amount of treatment charges (30 to 60%) demands flexibility on the organization providing the treatment. Evidence of this flexibility can only be provided by, in some way, measuring the results of these treatments.

Duplication of effort in the treatment chain not only means wasted effort and therefore extra costs in both IT and the hospital organization. It means that the throughputs of treatments are less than they could be because, on average, they take longer than they need to. Duplication of information

retrieval and storage allows more mistakes to be made because data is not unique. Longer throughput times translate to less income because on average fewer patients are treated. Similarly more mistakes than necessary translate to less income because putting wrong things right results in longer throughput and higher costs (due to the wastage of resources). All of these issues are critical success factors for a hospital because minimizing costs and maximizing income are vital for their survival.

The introduction of EPIC has an objective of addressing these critical success factors and Figure 4 describes the desired ("To Be") scenario. The treatment chain and the patients are now at the centre of the business process. IT enables the treatment chain to be more efficient because there is no inefficient duplication of information storage and retrieval. Organizations working on individual work processes see their work as part of the total treatment chain and not as independent from the chain. Average relative cost of treatment chains should decrease because there is less duplication of effort and better communication within each treatment chain. Lower on average throughput means more patients being treated and this will translate to higher income which in turn corresponds to lower costs from short-term borrowing. Less duplication of effort and information supports fewer human errors. Costs will decrease due to fewer mistakes and more efficient use of resources. The hospital's image will be improved.

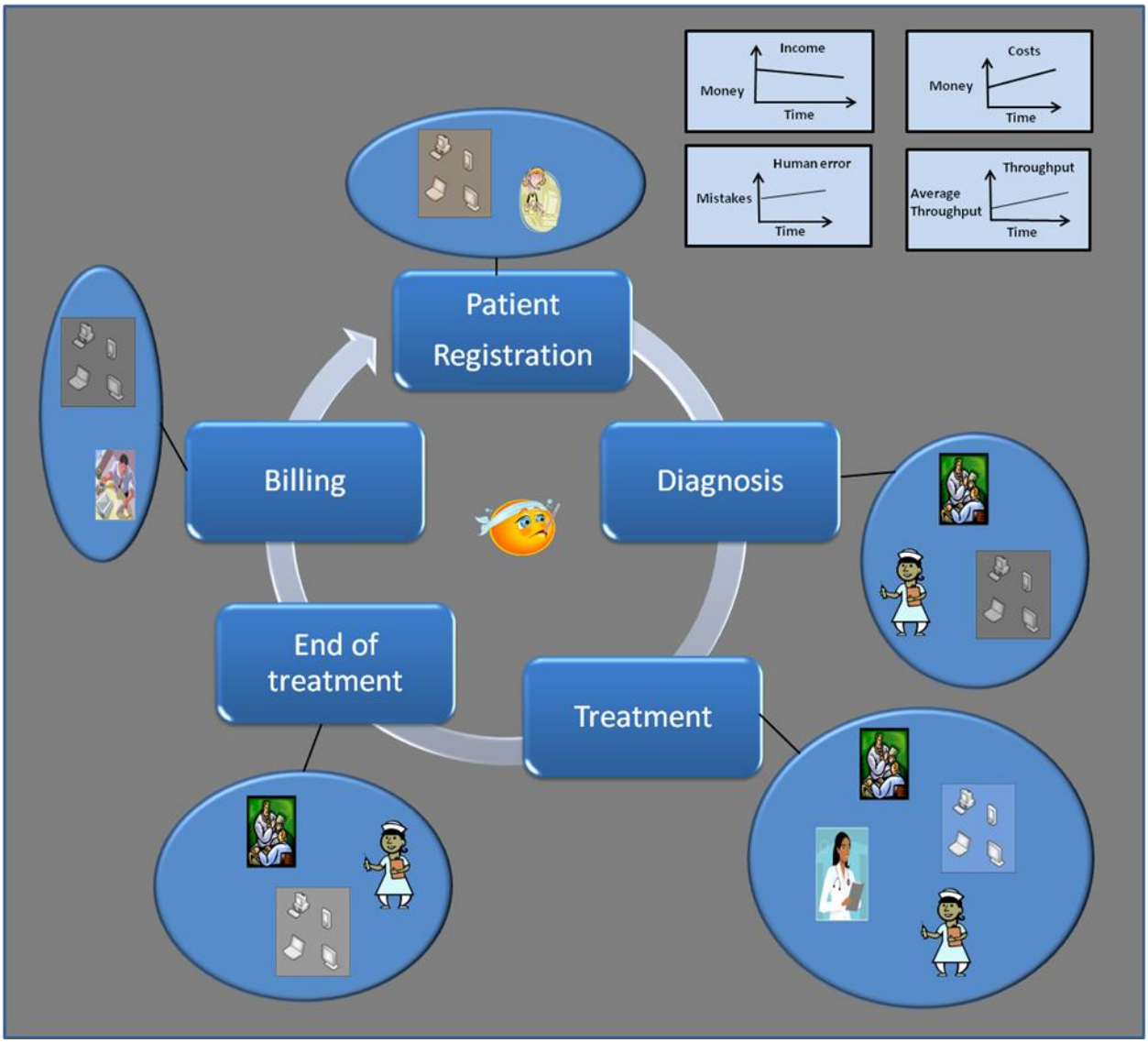


Figure 3 As Is – IT inefficient treatment chain

Figure 5 provides the context for moving from the "As Is" to the "To Be". The strategy has simply been to purchase a software solution to address the problems as stated in (Bruin 2008). Tactical responsibility lies with middle management. They are responsible for an organization that works together with IT to provide an optimal level of treatment care. The operations aspect is about the organization continually repeating their activities so that each patient receives an optimal level of care, with a minimal cost and over an optimal length of time.

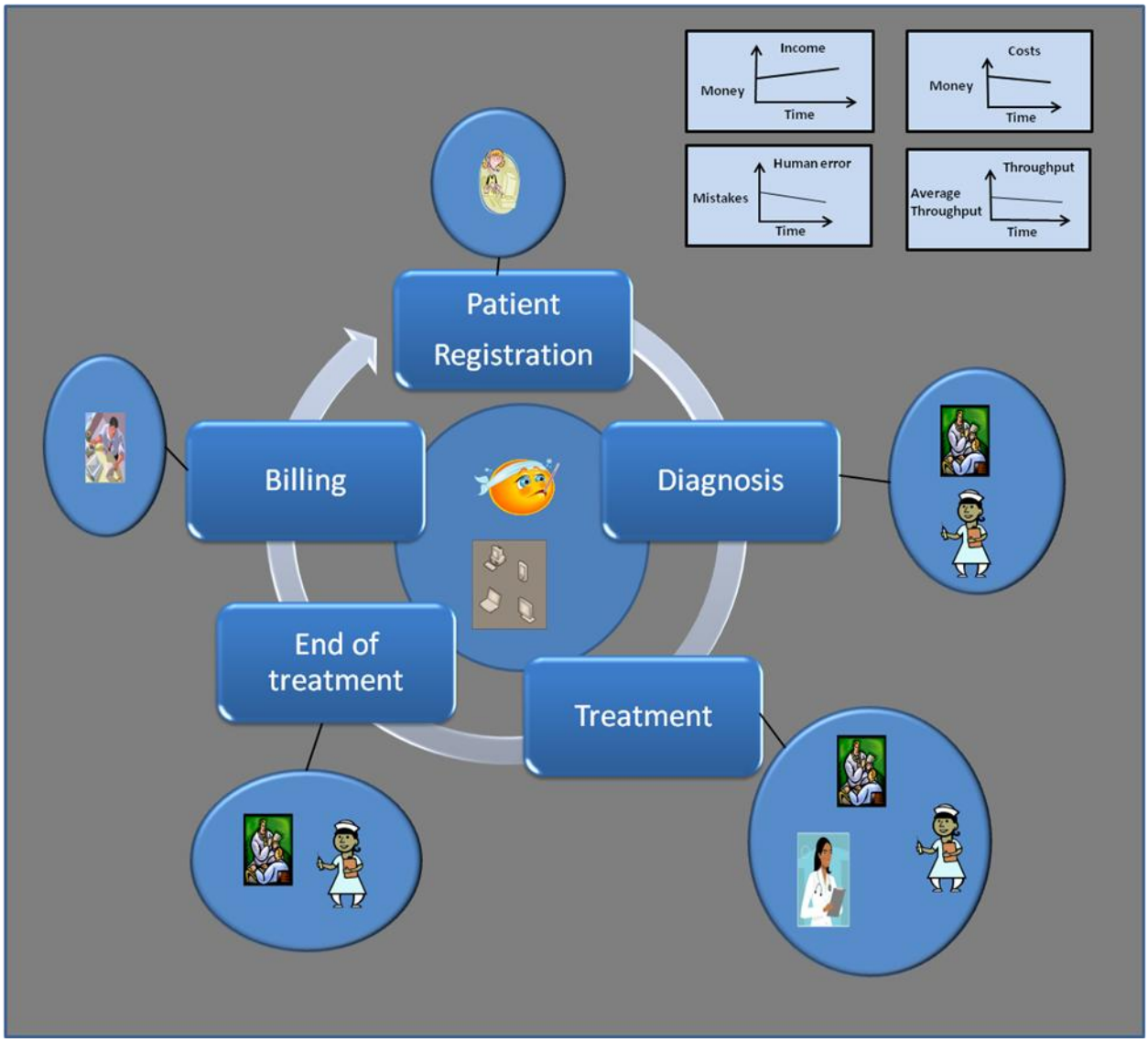


Figure 4 To Be – IT enabled, effective and efficient information exchange in the treatment chain

Responsibility for the investment in the solution lies at the strategic level and there is no systematic capability available to provide evidence that the investment has been paid back (ROI), when it has been paid back (payback) and if it has enabled the value to the customers who provide income to Spaarne hospital.

(Porter 1996) differentiates between operational effectiveness (OE) and strategy. Operational effectiveness in healthcare means performing daily treatment activities better than previously (that is, competing against oneself) or better than other healthcare establishments who are performing the same types of activities. (Porter 1996) describes strategy as deciding what to do and what not to do and that it has three important characteristics: positioning, trade-off and fit. Positioning is deciding on the best way to approach customers. Variety-based positioning is where the provision of a product or service is the focus rather than customer segments. Needs-based positioning is the targeting of customer segments. Access-based positioning is segmenting

customers depending on the best way to approach them, examples being location and customer scale. Trade-offs are required to make sure that incompatible activities are not performed which would otherwise increase inefficiencies and limit competitiveness. Strategic fit is minimizing wastage between the interactions of activities so that they rely on and strengthen each other.

Spaarne hospital has a needs-based strategic positioning because it is people focussed and has different patients having different types of need. Strategic fit is about creating treatment chains in which the activities in the chain complement each other so that value to the patient is maximized. There are no strategic trade-offs for Spaarne because it does not provide a specific specialism in exceptional medical care. We do see the necessity of strategic trade-offs being introduced in the future because of the market-oriented trend towards a regulated free market (Eenennaam 2007) in healthcare and the competitive developments around income from DBC's.

Figure 5 the change process

(Michael Porter 2005) mentioned in his presentation on redefining healthcare in the United States that cost was not the main issue. The main issues are; (i) access to healthcare (including health and insurance), (ii) deciding what healthcare should be covered by society and what by the individual and (iii) structure of healthcare. Unlike the United States, Dutch healthcare is not private based. Nevertheless they do have to balance their books. Cost and income are just as important to public organizations as they are to private organizations. When costs are continually greater than income the result will eventually be bankruptcy for both types of organization (Bruinsma 2006). Access to healthcare and a decision on what healthcare should be covered are outside our measurement framework scope. Structure of healthcare is purely about delivering increasing value over time. Business benefits from an investment in IT relates directly to providing value. Therefore the structure of healthcare is in the scope of our framework.

A model that provides a measurement of the business benefits will provide information on the value of healthcare. A model that provides an accurate relationship between the investment and the benefits supports an insight into, paraphrasing (Michael Porter 2005), "the value of every dollar spent".

We propose therefore that the objective is to provide continual systematic insight into the value of operational effectiveness and map this information back to strategic positioning and strategic fit. The next step is to define what we need to measure and when we should measure.

3.2 What is measured and when?

Before wading through masses of available literature we need to clarify what type of measurement is relevant and when we should measure. This will provide us with a requirement on the type of framework to build and the type of models to review.

We propose that an investment in IT can be separated into two phases. The first phase ex ante occurs before an IT investment has been put into use (common parlance for in use in the IT trade is “in production” or “live”). This phase can be described by the design, development, and integration and testing of a new software application before it is installed into the live system. The second phase ex post is after this application has been installed and is in live use. Very often these two phases are further complicated by the need to phase the introduction of extra functionality over a number of software releases.

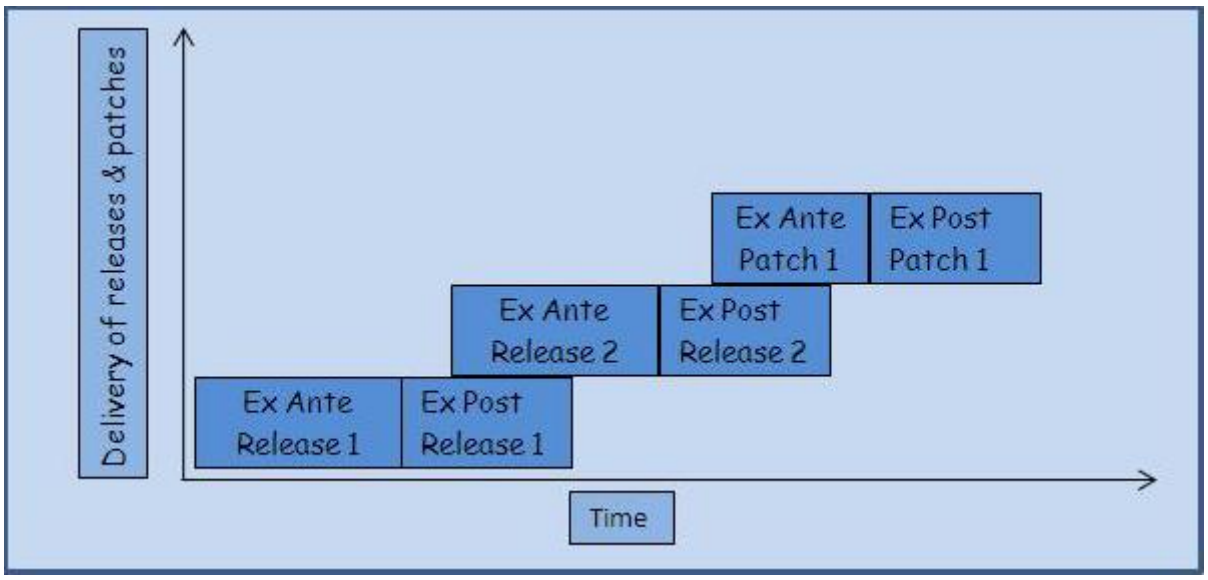


Figure 6 Availability of investment and business benefit variables

Figure 6 provides the ex ante and ex post context of this approach. Typically a help desk facility is initiated after the first release goes live. Once the last release has been installed the help desk facility will focus on registering incidents and facilitating the solution of problems. Solutions to problems can be provided by software updates, called patches, in the live system. The only difference between ex ante, for both releases and patches, is the amount of effort and therefore time required to produce a new software release. The reason is that patches are solutions to a small number of problems and a release is significant amount of new or changed functionality. Producing patches therefore takes significantly less time than for producing releases. The amount of effort to change the software in each ex ante phase is an IT investment.

With ex post there are two types of investment. Firstly, all overheads related to the cost of using the application. Secondly, all effort related to registering and solving problems. Both ex ante and

ex post processes are the same for off-the-shelf applications and applications specifically built or tailored for one customer. In summary, investment occurs in ex ante and ex post. Measurements of investment therefore need to be taken at ex ante and ex post moments.

Benefits from an investment only occur when a system[1] is in use because this is where income is generated. We can only therefore measure benefits ex post. These benefits are both direct and indirect outputs from the system. We therefore have to include the user organization (people) and the processes that are used for interacting with the system in our measurements. Variables that need to be measured are therefore the direct result of the system being used, the direct result of processes that interact with the system and the opinion by the user organization on how well these two variables are performing. The resulting measurements provide the value of an investment.

Difference between value and costs defines whether the investment has been a success or not. The problem is that value and costs both contain intangible and tangible variables. These variables are not of the same type. The apples and pears comparison challenge is therefore to define variables that can be easily, continually and systematically compared. An incomplete analysis is inevitable when there are incomplete measurements available due to some types of variables missing. This challenge is continued further with our literature review.

3.3 Literature review

The search for an understanding of a way to approach a systematic measurement solution began with the a review of the following books: (Renkema 2000), (Remenyi, Money et al. 2000), (Devaraj and Kohli 2002), (Boer and Zutphen 2002), (Berghout and Renkema 2005) and continued with: (Waal 2007), (Kaplan and Norton 2008) and (Beek 2006). A number of research articles have also been reviewed based on keywords and topics gleaned from the aforementioned books. Our objective has been to review as much as possible all the available models and filter out the ones we did not need.

We need to have a framework that allows us to measure the value against cost and compare them. Value being the set of business benefits and cost is the IT investment. A literature review has shown that there is no Holy Grail framework solution. This review did confirm that any framework has to include people, the business processes they use and IT together. The reason is that value is not created by IT; it is created by the user organization using the IT in a live environment. This is supported by a common academic agreement in our references that a measurement on ROI purely in monetary terms is insufficient. A framework for measurement has to therefore include both intangible (qualitative) and tangible (quantitative) variables.

Models that are useful for the framework are incomplete and therefore either require extra models glued on or they require significant knowledge and expertise to fill in the gaps. We could not choose the expertise approach simply because we do not have this expertise. We therefore had to choose a framework that was easy to use and optimally complete. Before deciding on a

[1] A system is composed of application software (EPIC), system software (operating systems) and hardware (computers, network devices and computer peripherals).

framework we needed to define what were the main constituents to be measured and what types of models supported an easy to understand structure.

In summary, we need to measure intangible and tangible variables of IT and its interface to a business. We need correlations within one measurement snapshot and we need to compare different measurement snapshots. The next challenge is to find models that we can use. This thought process is explained in the next section.

3.4 Relevant models

If the whole point of the exercise is to find out what people, processes and IT are doing together and compare this against an investment we need something that provides us with an overall view of these things together starting from the highest perspective, the strategic. The Balanced Scorecard (BSC), (Kaplan and Norton 1992) and Appendix B.1, provides different perspectives of a company with vision and strategy linking these perspectives. The different views are customer, financial, internal business processes and finally, learning and growth.

There are criticisms of BSC because it does not cover a supplier view, because of a weakness in the definition of the learning and growth view or because of an opinion that the definitions of intangible and tangible assets are incorrect (Marr and Adams 2004). We accept that, for example, the definition of assets might be incorrect as described in (Kaplan and Norton 2004) but our intention is to use the best parts of a model. A concept of assets is not within our context because our objective is to measure what there is. Cost is not an asset. Subjective opinion on the quality of an application is not an asset. There may be weaknesses in BSC but the helicopter view provided by the different perspectives is fit for our purpose. We do not intend to use the BSC as it is but tailor it to our purpose.

The customers in Spaarne are people who directly or indirectly use EPIC. Internal customers are administration and medical staff who directly use EPIC. External customers are patients who experience the affect of EPIC and therefore are indirect users. The financial view is addressed by IT investment costs and cost savings together with the income from payment for treatment. The internal business processes can be described by a description of the people involved and a description of the internal business processes that use cost or those that provide income. Learning and Growth and its aim of growth are related on one side to the affect of training and on another side through the effect of changes which provide progress through a different way of working. Including more than just a restriction of a financial perspective is an advantage of the use of the BSC. We need to tailor BSC so that we can define for each view the expected investment and the resulting expected benefits at a strategic level. This will provide the strategic reference against which the tactical and operational effectiveness can be compared.

The effectiveness of the internal business processes needs to be measured against the people influencing them or affected by them because this will provide a link between people, processes and IT. Viewed from a people perspective, this requires an analysis of people as individuals and people in a group.

Our case study provides a real-world example of the use of a new application by an organization. Any subsequent change in the way of performing activities requires a corresponding change in the organization that needs to use perform this activities. We are interested to know what this part

of the organization feels about change and how these changes will, in their opinion, affect them. We are also interested in the opinion of the parts of the organization that are not directly affected by the new application but they have been involved in the introduction of the new application – an example being the decision at board level to purchase the new application.

These individuals are together the stakeholders in the success of the new application. Stakeholder analysis, (Benjamin and Levinson 1993) and Appendix B.2, provides a mechanism for analyzing individuals in the context of the changes that are required and the benefits that could be received. Individuals in this stakeholder group maybe influencers of the EPIC programme without having to use EPIC or they maybe people who have to use EPIC. Insight into stakeholders allows one to influence their behaviour positively during transition from "As Is" to "To Be" and hence optimize the transition. It is also useful to know the opinion of these stakeholders after the transition so as to provide a barometer of its success.

Benefits Management, (Ward, Murray et al. 2004) and Appendix B.3, unlike BSC does provide a way to define the link between an IT investment and the resulting business benefits. The chain provided by a Benefits Dependency Matrix (BDN) allows one to move and correlate through IT investment, the people and resources, the changes that are required in the live organization and system, the resulting benefits to the business, the business objectives and finally, the business drivers that initiated the total change.

BSC specifies that success for the shareholders is the basis for the financial view. In our case study context we are simply interested in costs, savings in costs and income. Cash flow and not the shareholder is here the king. Appendix B.4 lists various theoretical financial models. All of which provide different views on reality. Finance is in one aspect the most tangible of all variables because money coming in and money going out can be extremely accurately measured. Problems occur when trying to assign costs to people and IT because activities that are used to calculate costs are performed by more than one person and IT entity and these people and IT entities themselves perform multiple activities. Assign cost to an individual is difficult because the start and end times of all resources that performed an activity cannot be accurately measured. How much cost can be assigned to a treatment chain from people who have been working on more than one treatment chain over a period of time? How can this cost be assigned between people, processes and IT? These questions are extremely difficult to answer. One point that this does highlight is the financial measurement problem here is a measurement of cost problem. This issue is further addressed in Chapter 4.

IT investment provides a system that is directly used by the end-user organization consisting of medical and administrative staff. Customers are either direct or indirect users of this system. There are therefore two types of qualitative opinion on the system. One is related to the perceived quality of training in the use of the system for the end-user organization. The other is the perceived quality of the system itself. These are both candidates for a questionnaire approach which has an objective of translating intangibles into tangibles.

(Remenyi, Money et al. 2000) have defined a ranking and scoring survey technique which is based on (Miller and Doyle 1987) as an attempt to convert qualitative opinion to quantitative information in the measurement of IT effectiveness. Their survey questionnaires are extremely detailed and therefore they increase the probability of misunderstanding in answering and analyzing the answers not to mention the fact that more questions decreases the probability of

getting answers to all the questions. Our approach is therefore to try and limit the questions by describing an object by its basic attributes. This will limit the number of variables and make the data gathering and resulting analysis easier. These basic attributes must also directly map to critical success factors and key performance indicators. We are interested in three different kinds of objects in our case study; (i) the patient logistic application as it experienced by the end-user organization (internal customers), (ii) the patient treatment process as it is experienced by the patients (external customers) and (iii) the effectiveness of training. All of these points are described by quality and we therefore need to find their quality attributes. (Pol and Teunissen 2002) describe quality attributes of IT from a testing context. The same quality attributes are relevant to a live system. The experience of the end-user organization can therefore be described with the use of these quality attributes. Insight into the perceptions of external customers is the next step after insight of the internal people, processes and IT has been achieved. This point is therefore treated as out of scope. (Lynn, Skov et al. 1999) and (Kirkpatrick 1994) provide models (Appendix B.5) on team learning and training evaluation. Together these models provide quality attributes for a questionnaire on the effectiveness of training. The training and application effectiveness questionnaires are explained further in Chapter 4.

If we use Figure 2 Patient care, as a reference and combine it with strategic fit concept from (Porter 1996) then it is clear that we need a mechanism for measuring the effectiveness of strategic fit on the case study internal processes. There are two different types of internal process of importance. One is related to the quality of the IT system. The other is the quality of the treatment. In a similar way to our questionnaire approach we need to know what the quality attributes are of both the IT system and treatment chain. Quality attributes of the IT system are covered by help desk support and the speed and effectiveness of solving system problems. Dutch healthcare now uses the concept of DBC to identify each different type of diagnosis and treatment. Quality attributes, from the perspective of patients, can therefore be used as a reference for the measurement on the effectiveness of the processes used in the treatment chain. Chapter 4 explains the definition and measurement of these quality-attributes in more detail by the use of a framework to perform and report on these measurements.

Table 2 highlights that all of the strategic requirements on model selection are satisfied, some of the tactical requirements are satisfied and none of the operational requirements are satisfied. Internal processes as represented by effectiveness of these processes and quality of the application can only be satisfied by measurements business process instances and quality attributes of the application as represented by minimum defects. Operational requirements are represented together by non-automatic and automatic data gathering. Non-automatic data gathering is directly related to human activities. Automatic data gathering is related to some form of business intelligence application.

4 Conceptual framework

Which framework can be used for correlating business performance with IT investment in a healthcare case study?

We now use the results of our review of available models as input for the definition of our framework. An objective is to optimize symmetry for simplifying the data gathering process and the resulting analysis process.

Section 4.1 provides an introduction of the BSC Tower and its three levels. Following on section 4.2 describes the strategic level and its mechanisms for providing the link between the business drivers and the investment. Included in this level are a strategy triangle and an analysis of the organization. The tactical level is described in section 4.3 and defines the types of variables we need to measure and how they should be measured. Physical measurement of these resulting variables is described in section 4.4, the operational level.

4.1 BSC Tower

Figure 7 describes our framework; the BSC Tower. It is an adaption of the Balanced Scorecard into three layers. The BCS Tower maps each of the strategic, tactical and operational management levels into their equivalent measurement levels. If management is generically about deciding what to do and checking that it has been done then our framework provides a means to produce evidence for the comparison between decision and results.

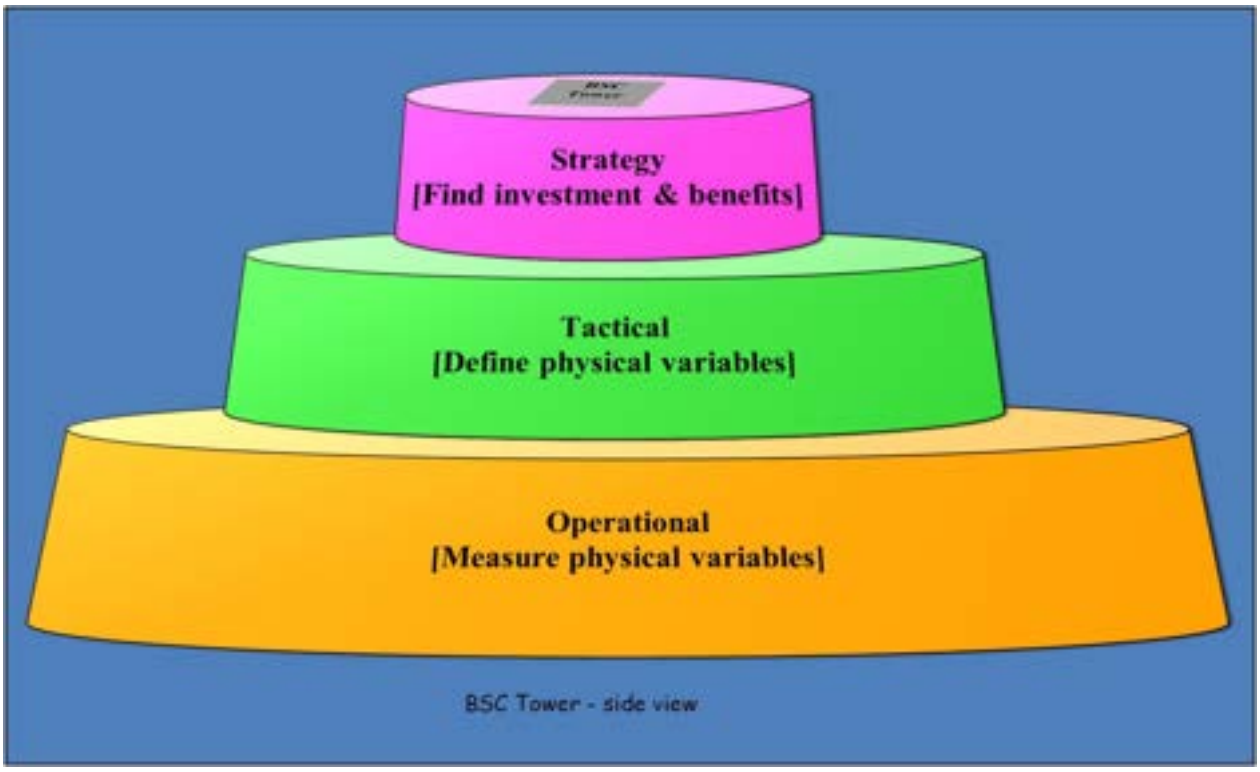


Figure 7 BSC Tower – strategy measurement to operational measurement

We are therefore interested at measuring what there is and comparing this against what was expected. Expectations stem from strategic decisions on what business outcomes to achieve and the amount and type of investment to invest in so as to achieve these desired outcomes. Decisions are therefore related to investment and results are the actual business outcomes.

The tactical level is used for defining the actual variables that need to be measured and how to measure them. Finally the operational level is the point at which physical measurements are carried out.

At the strategic level we need to know why a particular strategy has been chosen together with the expected business outcome and the investment choice that is required to achieve this outcome. Expected business outcome, in the form of business benefits and investment choice provide us with a description of the type of variables that we need to measure specific to the business domain in which we are measuring.

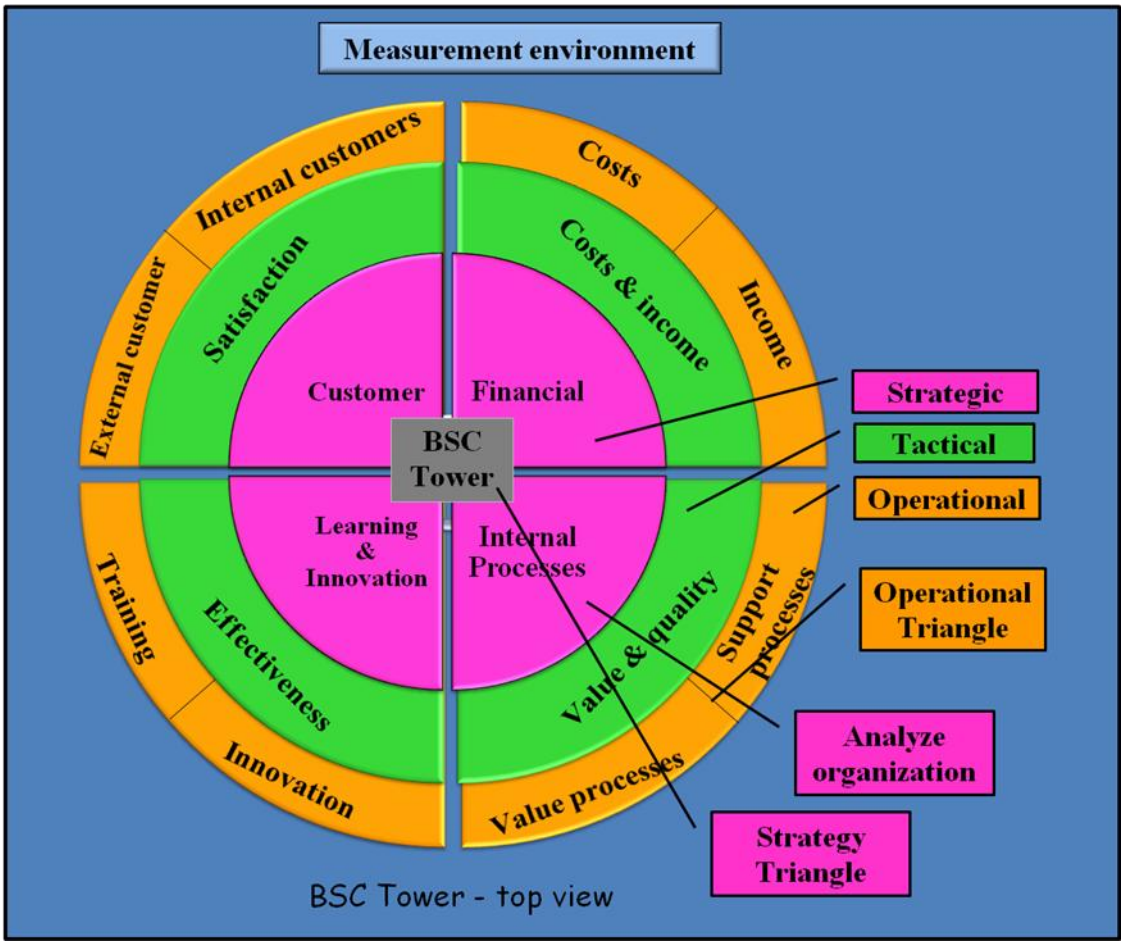


Figure 8 BSC Tower – as seen from above

Figure 8 provides a helicopter view of the BSC Tower and the different levels. The objective here is to show that the BSC views are represented at each level and that there is a link within and between the layers. The top layer provides the helicopter strategic perspective and provides the link between the business benefits and the investment together an analysis of the strategy.

Moving on to the next layer we have the tactical perspective which defines the variables to be measured for each of the different BSC views. The final and lowest perspective is operational which provides the results and analysis of full measurement. Figure 9 represents this process of defining through to measuring.

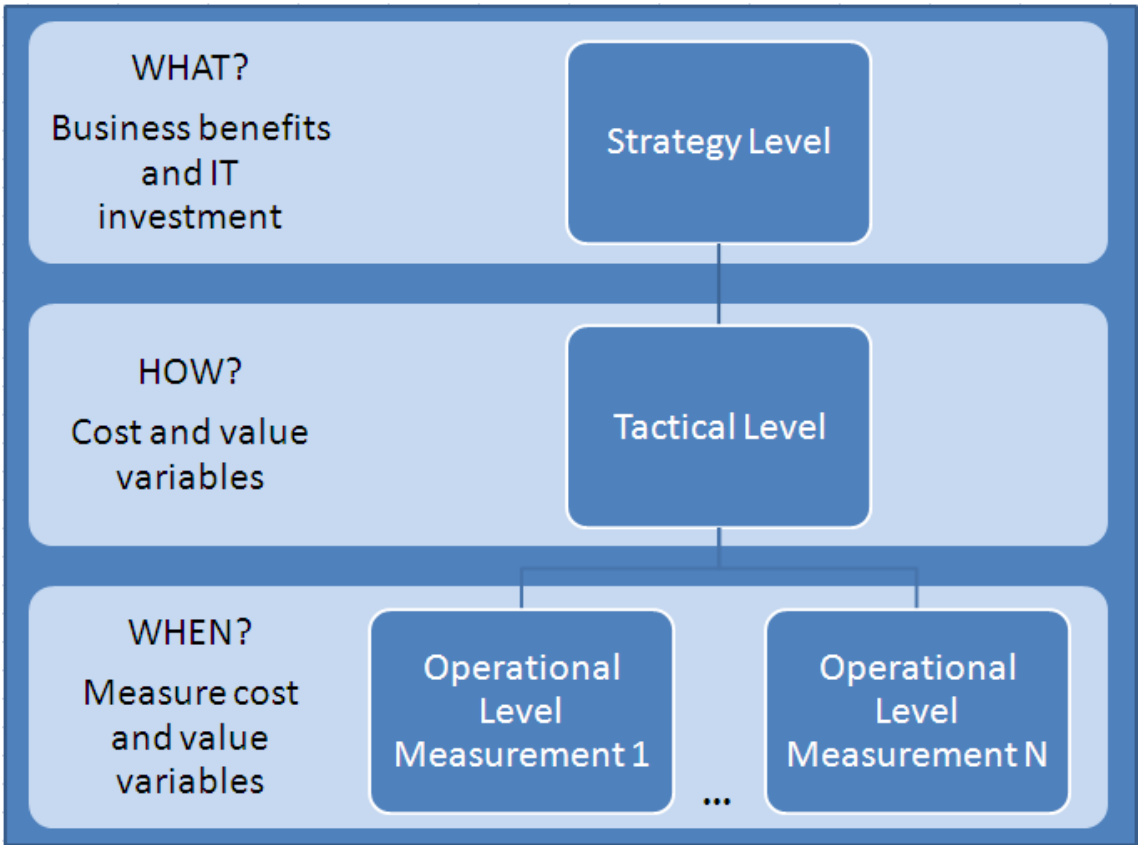


Figure 9 Strategy to Operational Measurement

In our case study, the customer view is composed of internal customers, who are the medical and support staff that use the application, and external customers, the patients and general practitioners who indirectly use the application. Costs and income represent the financial view. Training and innovation represent the Learning and Growth view. Internal processes are represented by support processes and value processes. Support processes are the activities to keep the application in use and repair problems when they occur. Value processes are those activities that are directly related to providing income and quality. The organization is represented by individuals and the end-user organization as a whole. Individuals have a vested say or interest in the success of the application and can be people within the end-user organization or people outside this organization.

4.2 Strategic level

Our context is solely measurement and supporting the strategic process. We are therefore not responsible for determining the strategy but for finding out what the strategy is and to map this strategy back to the investment. We use a Benefits Dependency Network (Ward, Murray et al.

2004) to map business benefits back to the investment in each of the separate BSC views. A Strategy Triangle, an extension of the strategy map (Kaplan and Norton 2004) which correlates the six combinations of the four view correlations, is used to compare and correlate business benefits between the BSC views. We now have per view, a chain linking investment with business benefits and a matrix correlating all business benefits together. In totality this is represented by Figure 10.

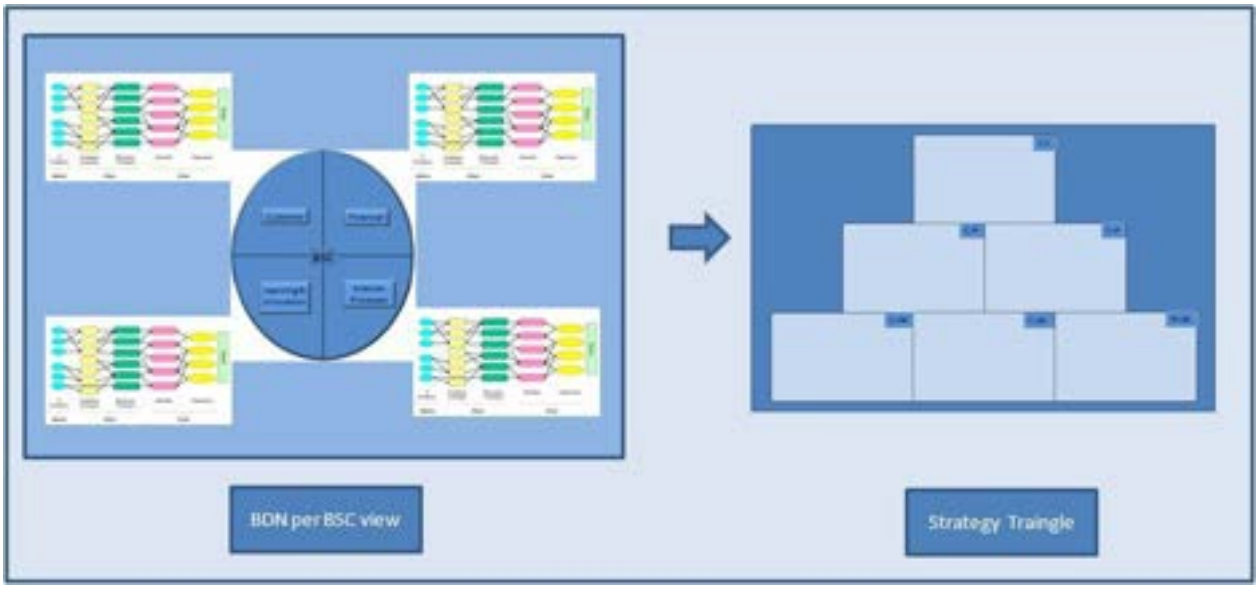


Figure 10 Defining and then correlating Business Benefits with the Strategy Triangle

An exception to the symmetry we are trying to achieve is the analysis of the organization in the internal processes quadrant. Analysis of the organization is focussed on the individuals and on the organization as a whole. We use stakeholder analysis to analyze important roles within the end-user organization or roles outside this organization that influence or are influenced by the use of the application.

SWOT analysis (Weihrich 1982) is used as a mechanism to describe the relationship between the internal environment being measured and external factors that might change this environment. It could be useful as an aid for comparing the strategy triangle against external factors. SWOT analysis is not continued further because it is not directly associated with further measurement. The BDN, as introduced in section 3.4, provides us with a description of the type of investment and benefit variables we need to measure.

4.3 Tactical level

The tactical level uses the description of types of investment and benefit variables from the strategic level to define exactly which variables need to be measured and how to measure them. Mechanisms for correlating within and between BSC views and between different measurement points in time are also defined in this level.

Each BSC view from the strategic measurement level provides us with the definition of which investment and business benefit variables to measure. Difference in type of variable and type of view dictates that symmetry between views in the tactical level is not possible. Measurement has

therefore to be defined with different models. Figure 11 provides this context. We use our case study to describe the models used in the following sections.

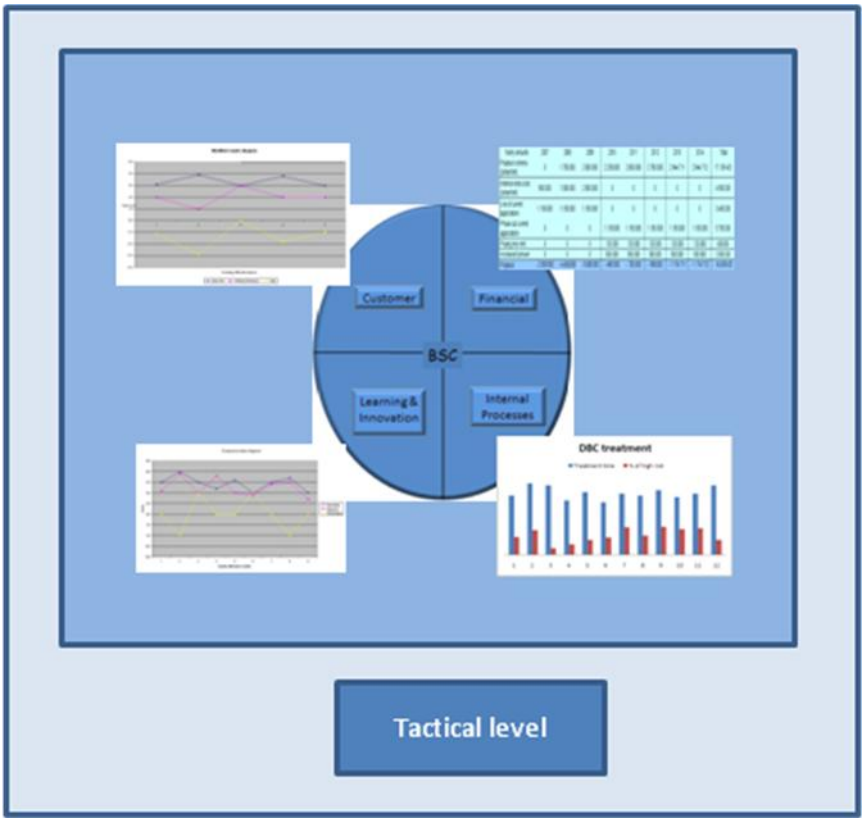


Figure 11 Measurements per BSC view

4.3.1 Customer view

Customer measurement in our case study is hard to quantify. It is only possible to find the opinion of customers. External customers represented by patients and general practitioners are not included within our research because they do not have direct access to the application and they therefore can have no opinion on the application. An analysis of the indirect effects of the application on these external customers is too difficult and too time-consuming. Our customer view research is therefore restricted to the intangible opinion of internal customers who are represented by the end-user organization. The availability of a portal for access to the case study application by both general practitioners and patients in a future releases will be a trigger for including these external customers in our measurements.

We use a ranking and scoring technique with survey questionnaires as described in (Remenyi, Money et al. 2000) which is based on (Miller and Doyle 1987) as an attempt to convert qualitative to quantitative information by comparing user expectations against the service provided with the case study application. We have changed the focus of the questions to quality attributes so as to optimize the number of questions and thereby simplifying the data gathering and resulting analysis process. Our quality attributes are those provided by an information system

in use and have been referenced from (Pol and Teunissen 2002). Source variables in this view are qualitative and therefore intangible.

We have separated the different questionnaires into four groups; (A) role and experience related, (B) importance of quality attributes, (C) expected experience of quality attributes, (D) actual experience of quality attributes. The same numbers of quality attributes are addressed in a different context in each of the different questionnaires (B) through (D). These quality attributes together with all questions are listed and an example of the resulting graphs are described in Appendix D. Questionnaire (A) will be used to provide finer granularities in the reporting and analysis process by providing the ability to separate statistics based on role and experience groups.

Value of the application to the end-user organization is their opinion on its quality. Our approach can provide an organization-wide opinion for use as a barometer of application quality. Graphs produced allow a pseudo-quantitative result that can be used as a solid base for analysis. The statistical significance of the sample (population sample answered compared to total population) is always included with results.

4.3.2 Financial view

It is not possible to calculate return on investment or payback period from an investment in IT without including income because IT does not provide income. Our case study as a non-profit organization receives two types of income for its supply of medical treatment. Budget is provided by the Dutch government. Completion of DBC treatment is paid for either by insurance companies or directly by individuals. Over a period of time the money received for each type of DBC can be accurately measured. The costs incurred for our IT investment are totally dictated by the way of working within the finance department of our case study. Whether we use costs directly provided by this department or whether we refer to Appendix B.4 depends on the finance department. The exact choices made are decided upon in the operational level. This view provides tangible variables because cash incoming and outgoing can be accurately recorded and therefore measured.

4.3.3 Learning and Growth view

(Lynn, Skov et al. 1999) and (Kirkpatrick 1994) provide attributes that can be used to measure the effectiveness of end-user training for the case study application. We use those attributes that provide insight into the quality of training on the use of the application in a live situation. These attributes have been combined with the approach of (Remenyi, Money et al. 2000) into a questionnaire. As with the customer view, our objective is optimize the number of attributes so as to minimize the number of questions. Data gathering and consequent analysis are therefore simplified. Our questionnaire, together with an example is described in Appendix E. Converting qualitative opinion into pseudo-quantitative information indicates that the source variables in this view are intangible. Measurement of innovation is too complicated to be dealt with in this thesis and is therefore out of scope.

4.3.4 Internal Processes view

(Tallon Winter 2007-2008) concludes that IT and business alignment of core processes, and the extent of right kind of fit at the process level, provide insight into business performance. The focus here is IT supporting individual processes rather than an entire strategy. Value of core processes together provides income. Payment for each individual treatment is activated when a DBC is started by a specialist. Income for the same treatment is activated when the treatment has finished. There are more complicated examples of this payment chain but they are all variations on this theme. From an internal process perspective the value of each treatment instance is related to begin and end time of the treatment and the quality of attributes in this treatment. The values of these attributes must be electronically stored by the application. Extracting these values over a period of time for all treatments will provide information on the effectiveness of the business results.

DBC characteristics can be split into DBC specific and patient type. (Ministry of Health 2009) provides a basis for the description of a DBC. Important patient characteristics are age, sex, disabilities (if existing) and risk on moment of diagnosis, which gives an indicator on how well the treatment is expected to end and when it is expected to end. DBC characteristics are primarily diagnosis, care question and type and treatment. Characteristics of effectiveness are time between registration and diagnosis, time between diagnosis and end of treatment, time between end of treatment and payment of bill and quality of treatment. Additional characteristics are information on the opening and closing of temporary DBC's and the switching of DBC's between hospitals. Chronic sickness results should be made available but they must be filtered out because these DBC's are closed and re-opened automatically every year.

(C.R. Gowen III 2008) refers to the use of Six Sigma for knowledge management within healthcare. Six Sigma is a process for minimizing defects. Fewer defects translate to higher quality. Therefore a higher quality of an application is correlated with fewer defects. The service organization must provide a record of incidents raised and the time taken to solve resulting defects that were related to the application. These statistics will provide a barometer of application quality of time. Fewer defects over time will provide evidence of an increase in quality of the application. At the tactical level, the internal process provides tangible variables. Appendix F shows examples of results for both quality of treatment and quality of the application.

4.4 Operational level

The operational level is simply the measurement of the variables, defined in the tactical level, at a point in time. Operational level measurements must be made at regular intervals so as to take into account any lagged effects from the original investment and also to enable insight into improvements from the investment. Time interval between measurements needs to take into account the length of time required to perform all measurements and the learning curve of the end-user organization. A more automated data gathering process will decrease the time needed to perform measurements and allow more frequent measurements. Gathering of intangible data should be facilitated with extra software. Tangible data should be available automatically but extra software will also be required to provide it in the necessary measurement format. (Spil, Stegwee et al. 2002) indicate that there needs to be a mechanism for providing disparate

information in an intelligent form within healthcare. Our approach is an example of this need. Cause and effect relationships described in the tactical level form the basis for an analysis of a measurement point. Similarly thresholds of improvement, status quo and failure defined in the tactical level are thresholds for traffic-light performance indication at the strategic level. A result of this reasoning is that some form of business intelligence is required for storing measurement results and for reporting on the result of correlation and analysis.

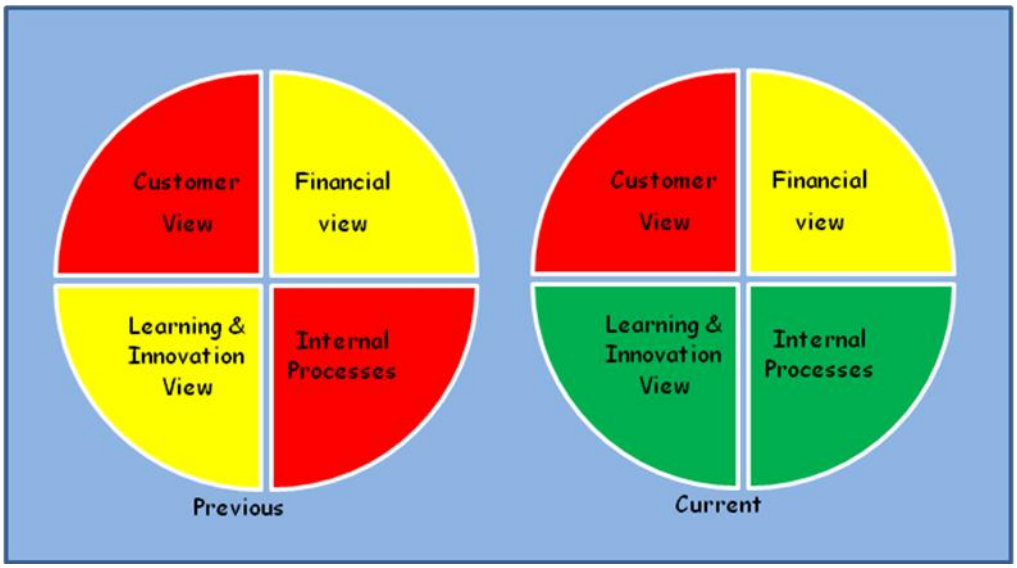


Figure 12 Operational level - traffic-light measurement example

Management reporting should be in the form of hierarchy with a reporting traffic-light at the top. At the top level it is possible to see directly which view has met the required thresholds and how the current measurement compares with the previous. Graphical summaries together with an explanation are provided for each view. An Operational Matrix is used to correlate measured investments and business benefits between the different BSC views. The resulting information is compared against the Strategy Triangle to determine if targets have been achieved and as aid to changing strategy if this is required.

Figure 12 provides an example of the top level reporting view. In this example, the financial view shows that financial targets are not being met but they are not at a dangerous level. The internal process view shows that the application quality is meeting expectations and patient treatment is effective and meeting targets. Training has been effective as evidenced by the Learning and Growth view. There is significant dissatisfaction with the application within the end-user organization and must be the focus of attention in the coming period.

5 Practical case

To what extent is the chosen framework useful for correlating business benefits with the healthcare case study?

This chapter describes the result of verifying[2] (refer to definition in Appendix A) our framework on the case study. It is the most difficult chapter because it involves the use of real-world data, part of which is available now but most of which will be available in the future.

Section 5.1 describes the strategic measurement level by an analysis of the organization both individual roles and as a group, a strategy triangle which correlates the expected business benefits and finally a mapping of IT investment to expected business benefits. Next we summarise our analysis of the tactical measurement level in 5.2. This level defines the measurement variables and their acceptance thresholds. It reproduces the ex ante, ex post idea described in section 3.2 as a basis for defining the actual investment and benefit variables that need to be measured. Last, but not least, section 5.3 describes the simulation of operation level measurements over a period of three years. We have used data that represents an improvement over this period.

We have interviewed our sponsor to get agreement on the research plan and have had access to stakeholders directly or indirectly involved in the application's development. Following on, we have interviewed the following roles:

- Manager of ICT at Spaarne (who was project manager for the implementation of the first release).
- The current (phase 2) implementation manager.
- An ICT project manager who has had experience, in a healthcare role, of care paths in other hospitals.
- Representatives of the finance department.
- A healthcare professional helping as a bridge between the end-user organization and the implementation of EPIC and who has direct experience of the in-use phase 1 version.
- The supplier project manager.

Our objective was to obtain a maximum amount of information that we could use to correlate with our literature research firstly as a basis for defining a measurement model and secondly for using in our own test with the case study on the measurement model. The results of the interviews are described in Appendix G together with an analysis and summary of the documentation that has been provided by Spaarne.

Most importantly the literature review highlighted that there is no theoretical measurement model available that covers the link between strategic, tactical and operational levels. We therefore

[2] Is it built right?

needed the time to create and improve our own measurement model that combines existing models into a framework.

We have used *our own test data* that is based on suggestions from case study interviews and what we expect to be useful from literature review, our analysis of the different BSC views combined with the capability of the EPIC application. We have decided not to directly use the Spaarne costs because of their sensitive nature. At the strategic level we have used information from Spaarne to define the benefit dependency networks for the different measurement views. We use different potential values of KPI's to represent what would be a larger set of real-world data. This has saved us time, by not having to generate and simulate large sets of raw data. We have simulated three operational measurements over a period of three years, one measurement per year.

The Stakeholder analysis data is based partly on interviews with some of the stakeholders who have their own opinions and their view on opinions from other stakeholders who have as yet not been interviewed.

5.1 Strategic level

5.1.1 Analysis of organization

Stakeholder Analysis

The following stakeholders have been identified after interviewing our case study sponsor:

1. Sponsor – member of the board who would like to see evidence of the payback moment for the business benefits from the investment in EPIC.
2. Medical staff – doctors.
3. Medical staff – nurses.
4. Medical staff – support.
5. Administrative staff.
6. Finance.
7. Service management, inclusive helpdesk.
8. IT.
9. Supplier.

The following table summarizes the relative amount of change required or affecting them ("the pain") and the extent of benefits received by the same stakeholder(group)s ("the gain"). The column "Changes required" contains a "+" when a lot of changes are required. An "+/-" indicates a medium of amount of changes are required and a "-" indicates that no changes are required. Similarly "+" in the "Benefits received" column indicates that a lot of benefits will be received, a "+/-" indicates that some benefits will be received and an "-" indicates no benefits will be received.

Table 1 Case study stakeholder analysis

#	Stakeholder(group)s	Changes required	Expected Benefits received
1	Sponsor	+	+
2	Medical staff – doctors.	+	-
3	Medical staff – nurses.	+/-	+
4	Administrative staff.	+	+
5	Finance.	+	+
6	Service management, inclusive helpdesk.	+/-	+
7	IT.	+	+
8	Supplier.	+	+

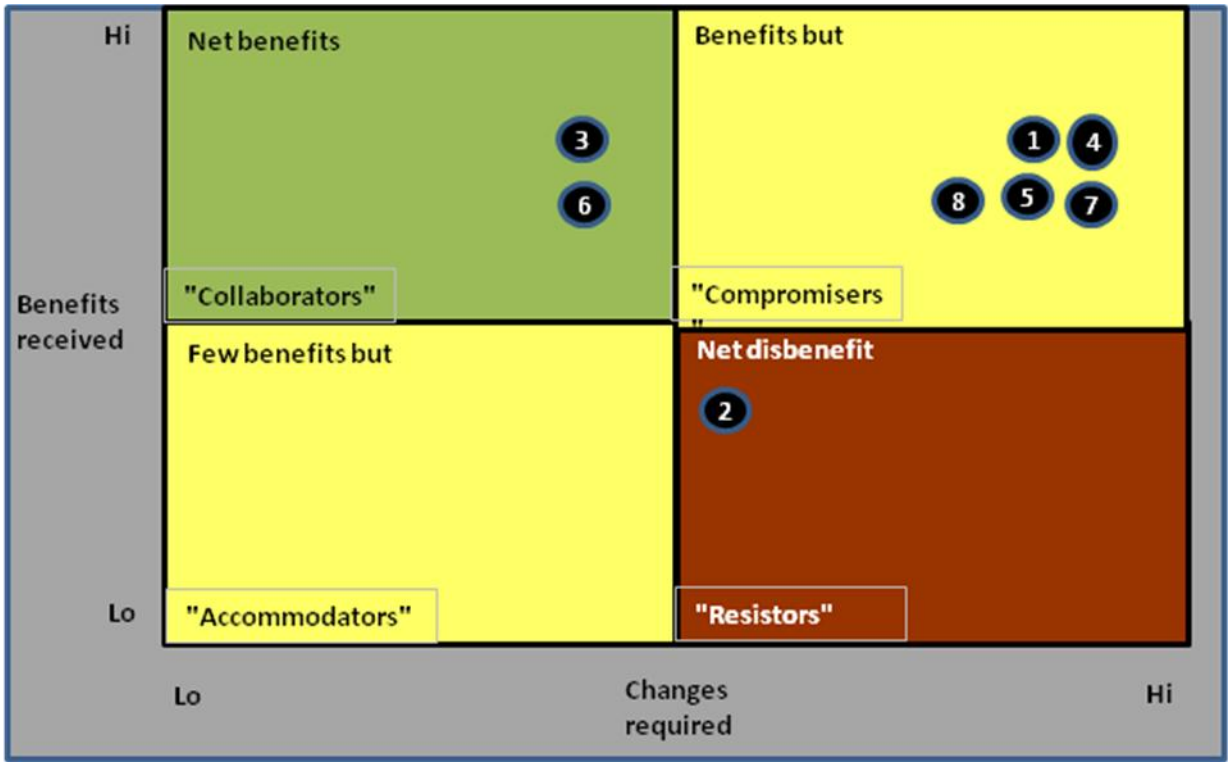


Figure 13 Spaarne stakeholders analysis

The same information has been plotted in Figure 13 which shows that our sponsor, administrative staff, finance, IT and the supplier are all enthusiastic about the introduction of EPIC but they are concerned about the changes. Nurses and service management are enthusiastic about EPIC but because the changes on them are limited they need to be aware of the implications for doctors. Resistance is represented by doctors, who do not want to change their working patterns and this must be addressed as part of the transition to the new patient-centric approach.

5.1.2 Strategy Triangle

Each BDN view in section 5.1.3 describes the required investment in IT to achieve an expected business benefit. The business benefits are in effect SMART key performance indicators. (Kaplan and Norton 2004) use strategy maps as an aid to correlating the cause-and-effect relationships between these KPI's. We have extended their strategy map to a strategy triangle because our objective was to describe these relationships not just showing the links. Each cell in our strategy triangle describes the relationship between the different types of KPI. In equivalent way to SWOT analysis the objective here is to highlight strengths and weaknesses from these relationships as an aid to the strategic decision process. At the operational level we describe the actual relationships based on real measurements. The resulting operational triangle should be compared against the original strategy triangle so that strategic changes can be made, where necessary and thereby facilitating a continual improvement process between strategy and operations.

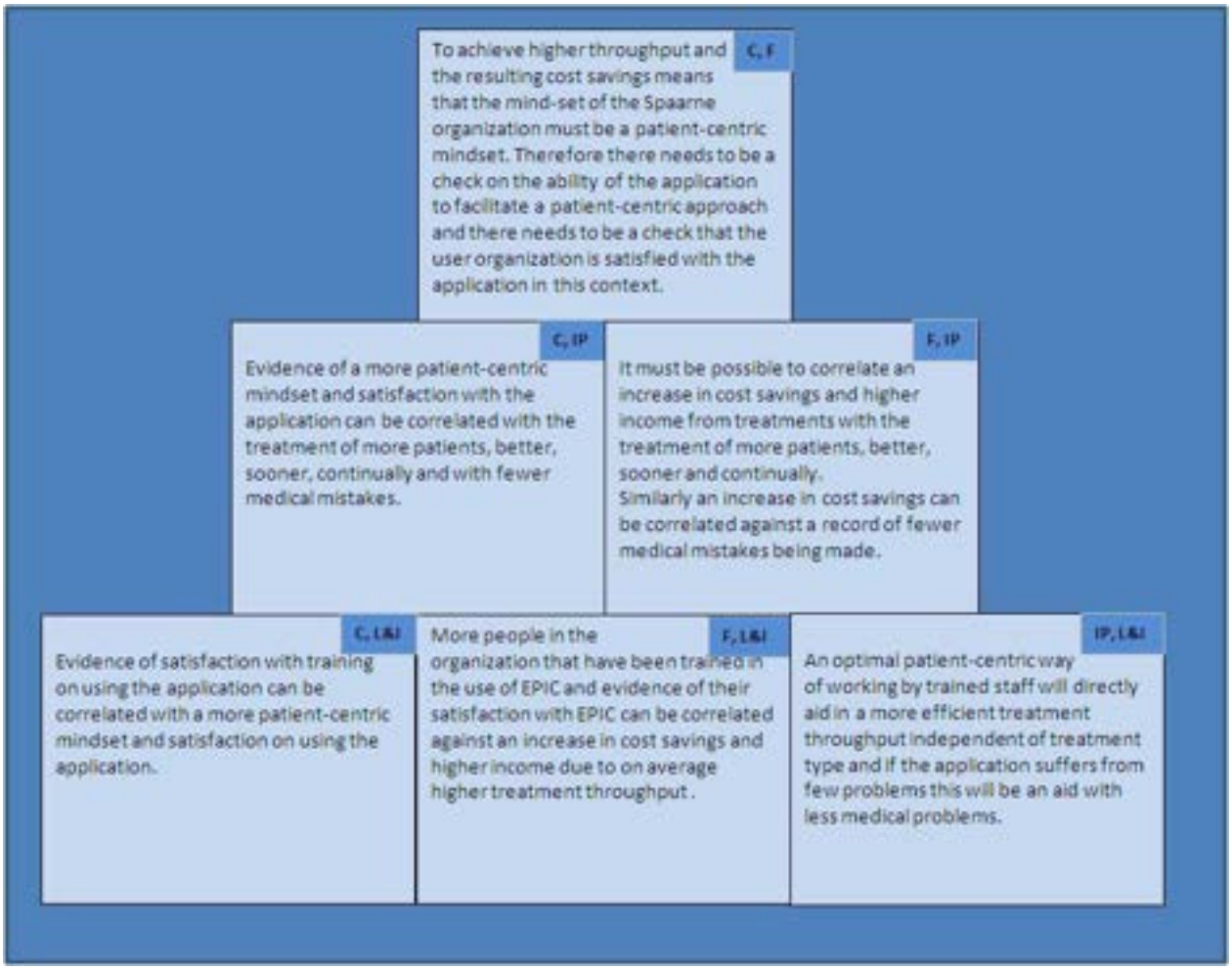


Figure 14 Correlating strategic expectations from the business benefits networks

Figure 14 uses the business benefits from each BSC view, as described in section 5.1.3 to correlate the strategic decision from each view.

5.1.3 BDN views

Figure 15 indicates how a conscious investment in optimizing quality attributes in EPIC, related to the patient-centric way of working, and the verification of this investment with testing, will provide both an aid in changing the organization's mindset to this way of working and will ease the acceptance of EPIC by the organization.

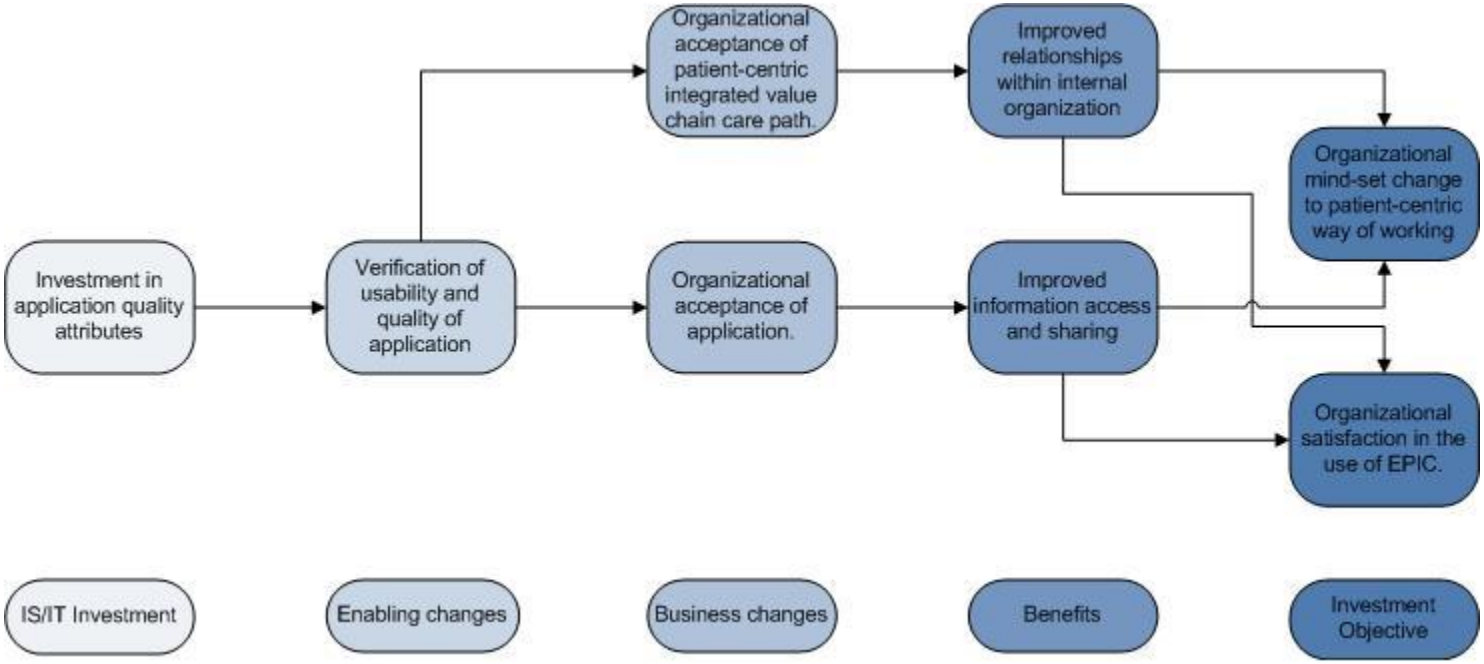


Figure 15 Customer view - Correlation between an investment in quality and expected benefits

Figure 16 clearly describes that investing in an application that provides an integrated care path will provide cost savings from paying less rent on borrowed money because, on average, treatment paths will be shorter. Because these treatment paths are shorter more patients can be treated in the same time, therefore more income can be generated.

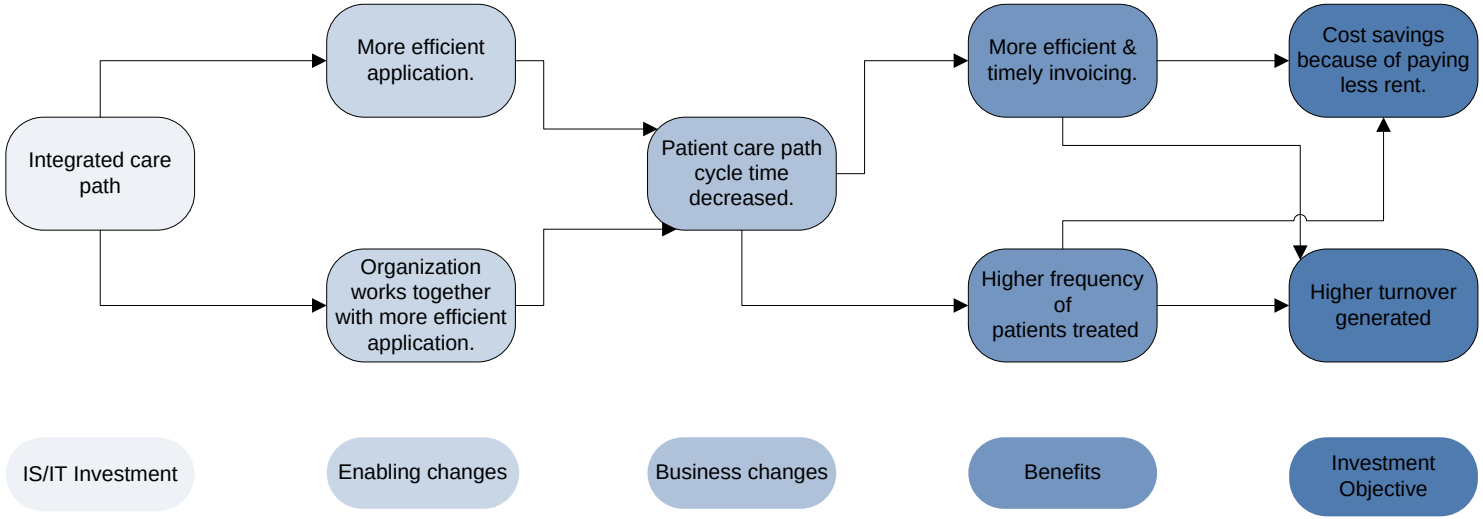
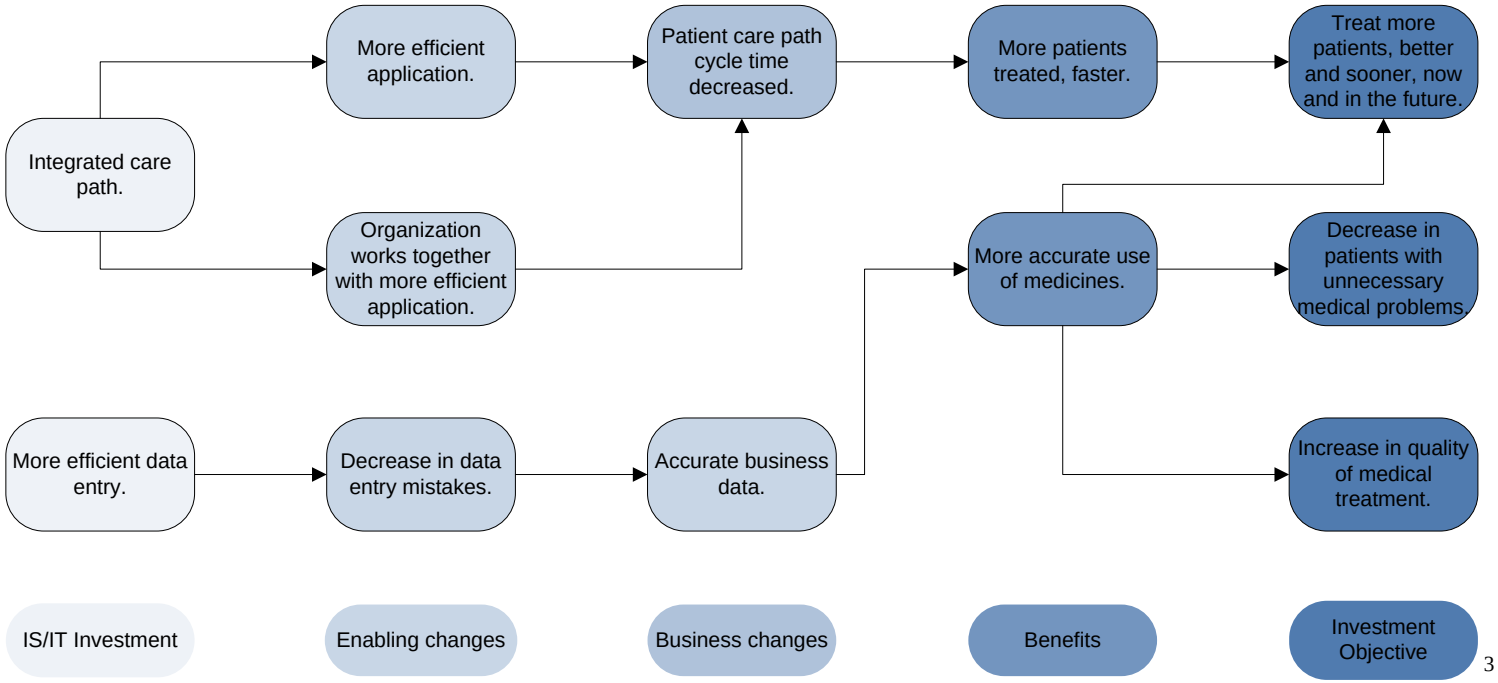


Figure 16 Financial view – correlation between financial investment in an integrated care path solution and cost savings and higher income benefits

Figure 17 shows that an investment in an application that provides an integrated care path which provides an efficient data entry can result in an improvement with the internal processes due being able to create and use patient information more efficiently and seamlessly. This can benefit the business by facilitating the treatment of more patients and a decrease in medical mistakes. In general, the internal processes can facilitate a general increase in the quality of medical treatment.



[3]

Figure 17 Internal Process view – correlation between investment and cost savings, higher income and quality improvement

[3] Treat more patients, better and sooner, now and in the future. (Wright & King 2006)

Figure 18 highlights that an investment in training on the use of EPIC can facilitate a more patient-centric way of working because the end-user organization will know how to use the patient-centric facilities of EPIC after a more optimal training.

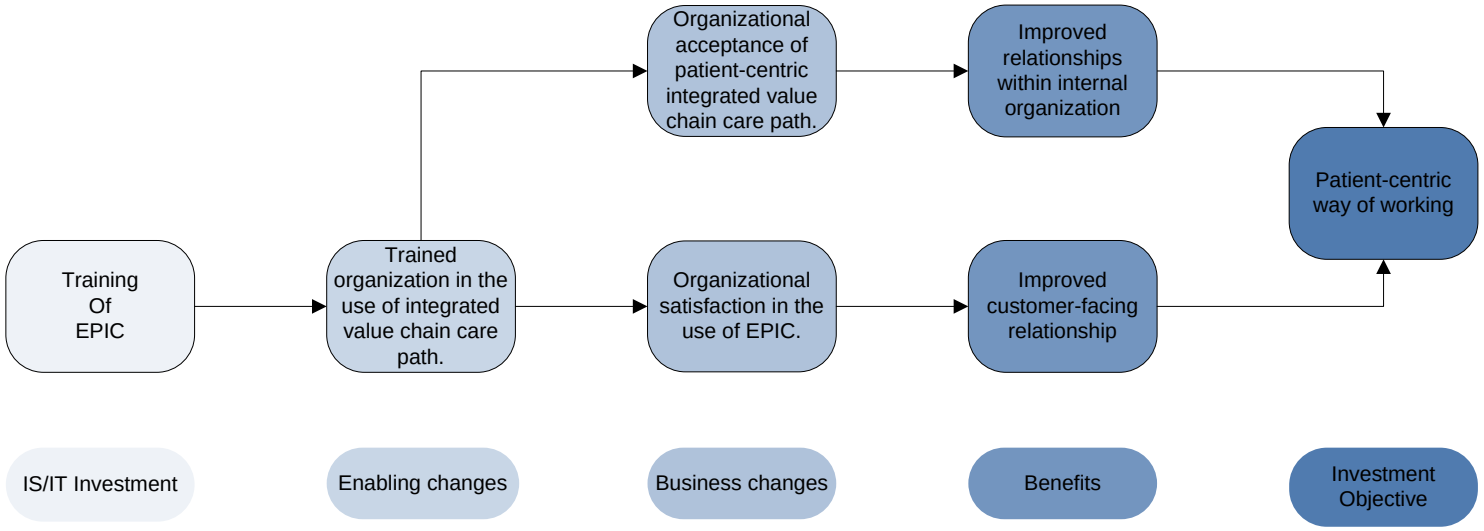


Figure 18 Learning and Growth view – correlation between an investment in training and a more patient-centric focus

5.2 Tactical level

We can now translate the IT investment and expected business benefits that have been defined at the strategic level, into definitions of variables that we can measure. IT investments are the critical success factors because they are critical to the achievement of the business benefits. The business benefits are key performance indicators because they provide the barometer of success. Figure 6 provides a picture of when we need to measure. Everything before going live, with a release or patch, is ex ante and a measurement of investment. Ex post is the application being used in a live environment and is a measurement of both investment and income. Each BSC view is different; therefore the decision on what to measure and in which ex ante or ex post phase is different. The BDN for each BSC view in the strategic level is used as input for defining the variables to measure and the type of variable dictates which phase it should be measured in.

5.2.1 Customer View

We have restricted our measurement of the customer view to an opinion by the end-user organization on the quality of the application. Section 4.3 refers to a questionnaire to be used for determining the end-user opinion on the quality of EPIC. This questionnaire provides three different types of question, expected quality, experienced quality and importance of quality. Expected quality and importance of quality are not strictly investments but together they do describe a form of critical success factor. The experienced quality is a subjective measure of business benefit. The questionnaire for the customer view can only be completed with experience of EPIC in a live phase therefore this measurement is only valid in an ex post context.

A detailed description of the hospital organization and the different types of roles needs to be known for defining the characteristics of this target population. Either a sample of this target population is approached to answer the questionnaire or all members of the population are asked via a convenient medium like the hospital intranet. In both cases an analysis of the results will include a statistical significance based on the percentage of people who have answered the questionnaire compared to those that could have answered the questionnaire.

5.2.2 Financial View

Unfortunately the only business benefits from a financial perspective are income from DBC treatment and cost savings. DBC treatment is paid for by government budget, insurance companies and, sometime, individuals. Value of these payments must be gathered to provide total figures and figures per DBC type of treatment. Cost savings which are savings based on lending less due to quicker payments from higher treatment throughputs must be gathered also on the basis of a total and per DBC type of treatment. By definition all types of income are measurements ex post because they are characteristics of EPIC in a live system. Costs are based on a fixed price contract which is known for the coming six years. This covers both costs for development and support for EPIC in a live system. Development is ex ante and support is ex post. The charge pattern of the EPIC supplier is such that the granularity of costs is a combination of ex ante and ex post in one. As mentioned in chapter 4, financial terms such as ABC or TCO can only be used if they are used by the financial department of the organization under investigation. It is therefore not possible to accurately determine the additional ex post costs of

overhead related to the support of EPIC by Spaarne itself. For this reason these costs are not included within our measurement. NPV is used as a forecasting method to calculate the value of money in the future. We are only interested in measuring exactly what there is therefore NPV is of no use. Inflation is the only real term relevant to our valuation of money at a point in time. Our accurate measurements of costs, cost savings and income will include inflation in our results as an option. The value of inflation used is the value of inflation at the time that the payment is received or the costs and cost savings are incurred and not the time in which the measurement was made.

5.2.3 Internal Process View

Both measurements of DBC qualities and EPIC incidents to be solved in a live environment are by definition ex post measurements. An investment in application quality attributes can be inferred from a verification of the usability and quality of EPIC during its testing before going live. This information is ex ante and should be available as part of the test acceptance report and forms a basis for the expected quality of the application. The DBC qualities and EPIC incidents as described in chapter 4. This information must be available from EPIC itself for DBC and the helpdesk for incidents.

5.2.4 Learning and Growth View

Chapter 4 describes a questionnaire for finding out the effectiveness of training on the use of EPIC. Our population size is restricted to people in the Spaarne organization that directly use EPIC and therefore (ideally) require EPIC training. The approach to getting answers is exactly the same as with the customer view. The only differences are content of questionnaire and target population. The effectiveness of training can only be measured in a live environment therefore this measurement is one of ex post. Another possibility for growth in the form of innovation is a simple count of improvements in operational activities that are facilitated from the application (IT enabled).

5.3 Operational level

The objective of the operational level is to provide measurements within all the BSC views and correlate these views together and compare everything against both historical results and expected values. Different kinds of measurements are made and combined within each view into a traffic-light result. An individual measurement is considered to be green if it is identical to or above the expected threshold, amber if it is below the expected threshold but better than the previous measurement and red if it is below the threshold and the previous measurement. If there is more than one type of measurement within a view the worst result is used for the traffic-light summary. For example, the internal processes view has measurements of type DBC quality and application quality. If the DBC quality measurement result is red and the application quality result is green the traffic-light colour for this view will be red.

The following sections describe a simulation of three measurements taken respectively in 2009, 2010 and 2011. Justification for this approach is an expected improvement after a time lag in which the end-user organization has learned to use the application.

Section 5.3.1 summarises the measurements in a way that could be provided to higher management. The traffic light display highlights progress in each view. The operational triangle can be used to correlate results between views and for correlating against the strategic triangle for analysis of the alignment between strategy and operations. Sections 5.3.2 through 5.3.5 represent actual measurements that could be accessed by a drill-down action.

5.3.1 Correlated operational level results

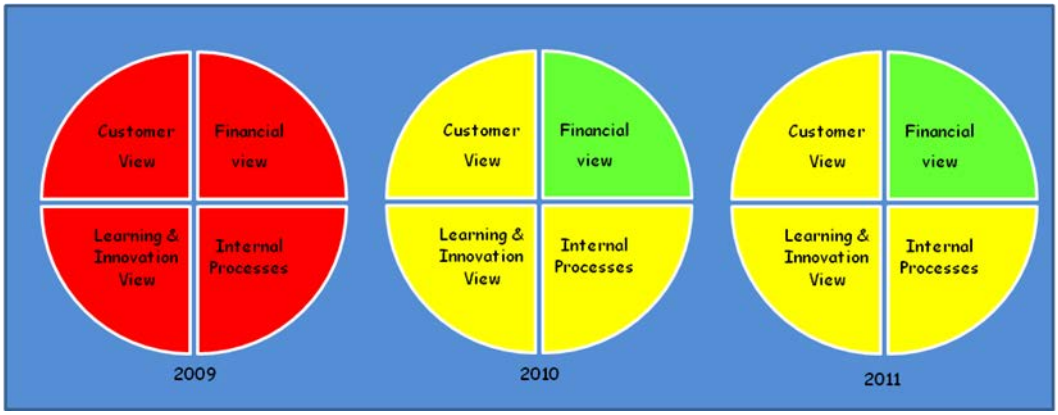


Figure 19 Measurement summaries from 2009 to 2011

Figure 19 shows the results of one measurement that was taken every year from 2009 to 2011. In 2009, all results are worst case because it is the first measurement and there are no significant positive results. The end-user organization is not satisfied with the application. Improvements in the application and training in its use need to be investigated as do treatment activities related to the patient-centric capability of the application. These points are summarized in the operational triangle for 2009 in Figure 20.

Improvements have been made in 2010, as can be seen from the amber quadrants of customer, Learning and Growth and internal processes views. Customer satisfaction with the application is

higher in addition to higher expectations of the application. A move towards a requirement of improvements on stability is evidenced by a preference of better information processing and more efficient use of resources together with a demand for quicker turnaround of both interactive and batch processes. There has been an improvement in DBC related treatment characteristics but they need to be further improved. Application incidents have decreased but they need to be decreased even further. These points are summarized in Figure 21, the operational triangle for 2010.

Further improvements have been achieved in 2011, as can be seen from the operational triangle summary in Figure 22. DBC key performance indicators have improved as has the application quality. There needs to be an investigation of investment in training of staff and improvement of the application around its weakest quality attributes and the weakest types of DBC's. We are also now at the point to prioritize and address the weakest areas of difference between importance and expectations of the application.

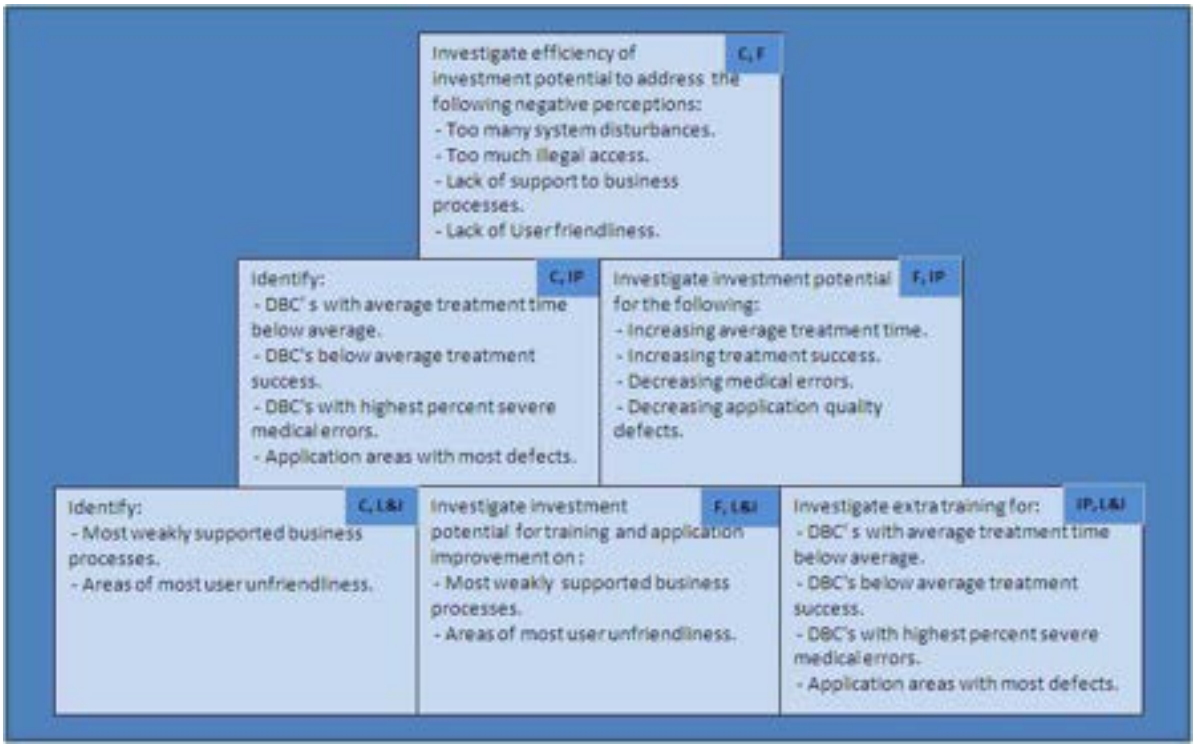


Figure 20 Operational triangle – 2009

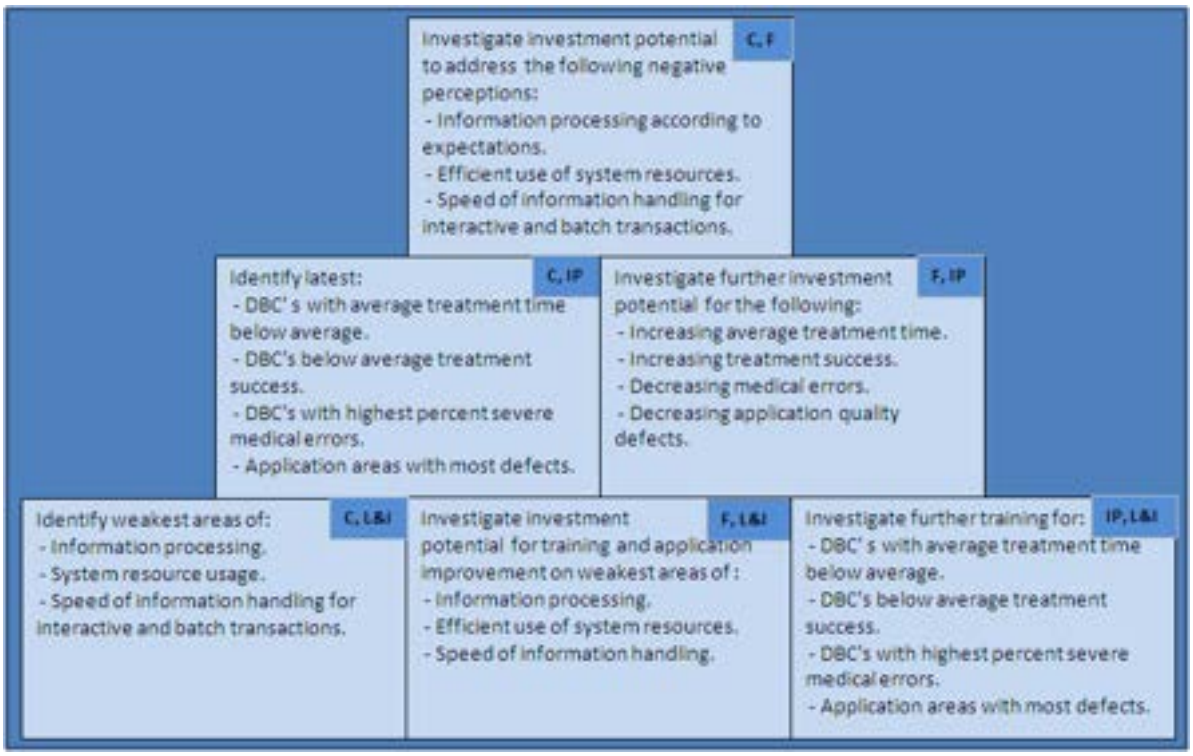


Figure 21 Operational triangle – 2010

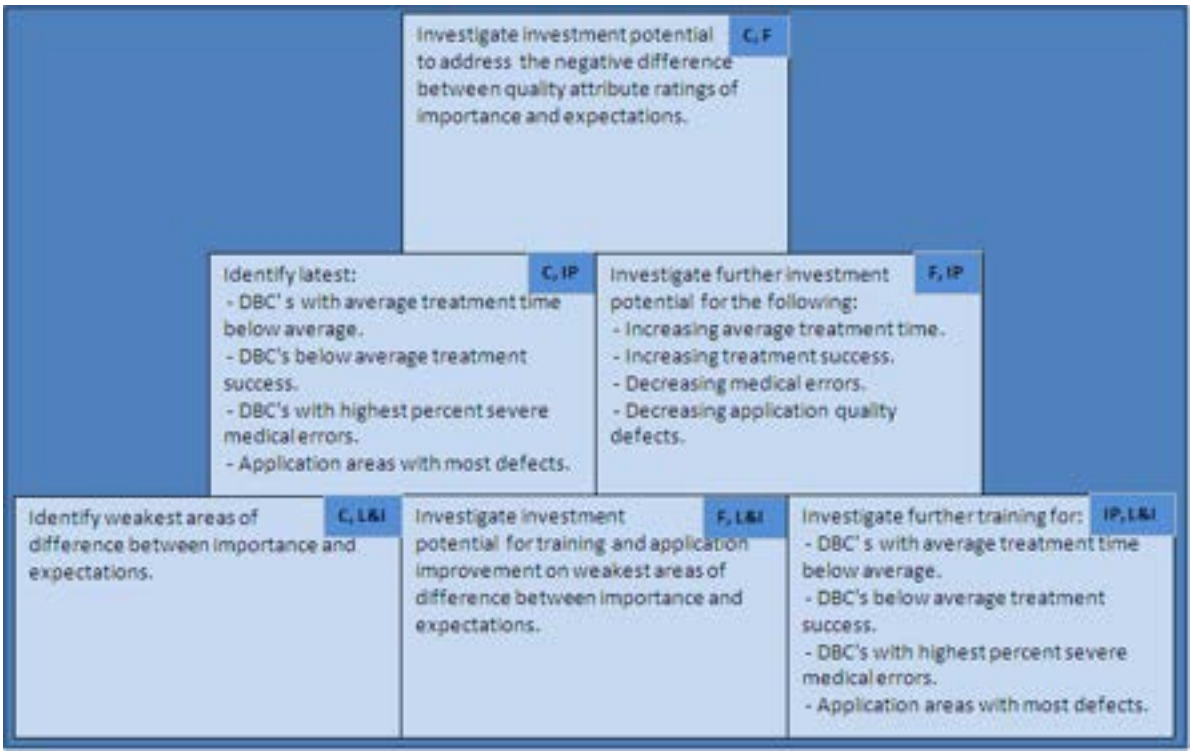


Figure 22 Operational triangle – 2011

5.3.2 Customer View

All results in this view have been simulated. Table 3 describes the meaning of each of the quality attributes.

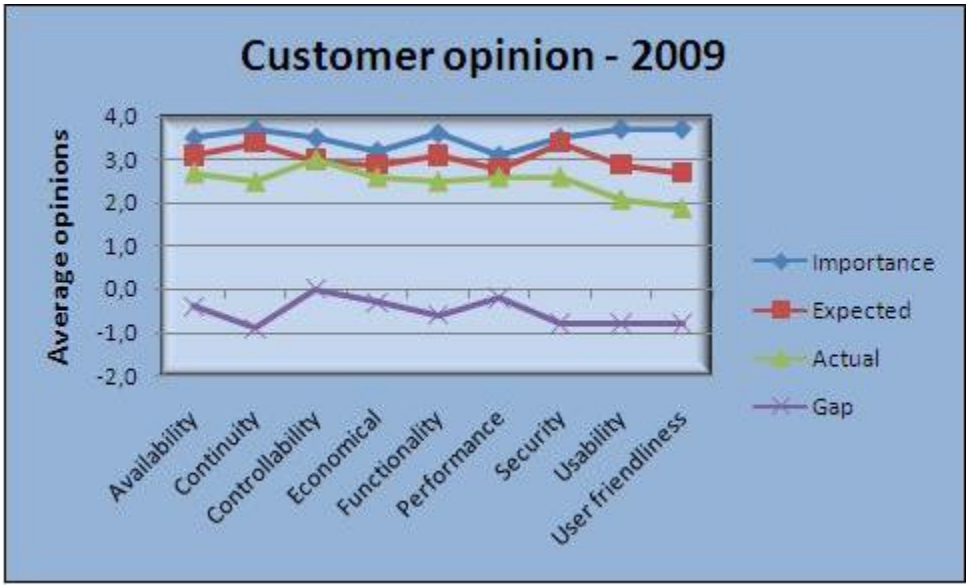


Figure 23 Performance of application for customer in 2009

Figure 23 shows the results for the very first measurement which indicate that the end-user organization has mostly lower expectations than the importance that they consider for the application's quality attributes. Actual end-user experience of the application is less than was expected. There seems to be a satisfaction with the ability of the application to process information and keep information correct because the audit capabilities of the application prove this. Nevertheless, the status of this measurement is red because most results are less than expected and there is no previous measurement. The end-user organization is not satisfied with the ability of the application to continue working when there are disturbances. Security and the ability to easily learn how to use the application are not highly thought of. The end-user organization has the opinion that the application has not been tailored enough to meet their needs.

Measurements from Figure 24 show that the expectations of the capability of the application are in general less. Ironically organizational experience is closer to their expectations. Performance of the application is now considered to be an issue. Actual and expected experience of security, usability and user-friendliness is now rate lower but are still considered to be important. The status of this measurement is amber because even though there are still attributes below the expected threshold there is an improvement in comparison to the measurement from 2009.

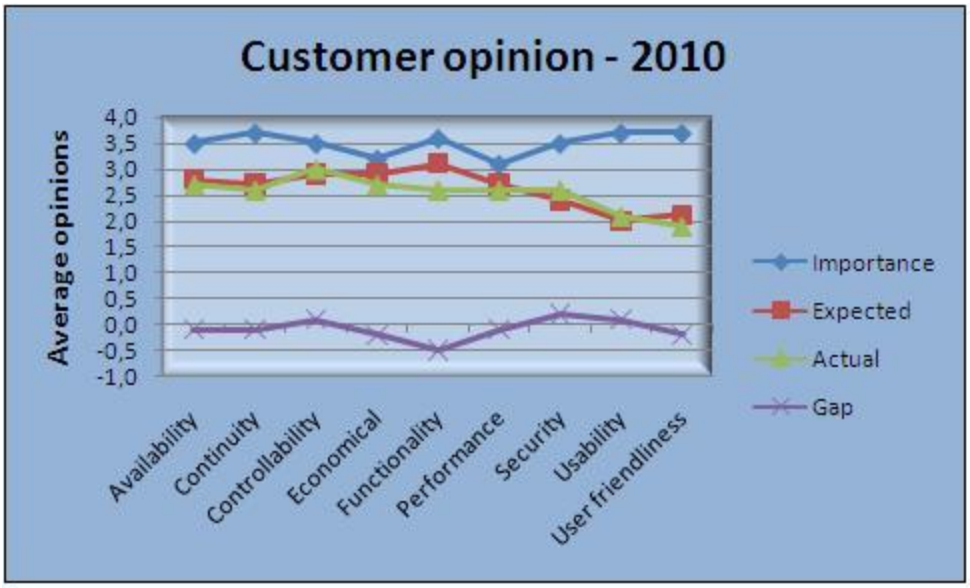


Figure 24 Performance of application for customer in 2010

Figure 25 shows that the end-user organization is now more satisfied with the application. Even though most attributes are still below their threshold they are closer to the threshold.

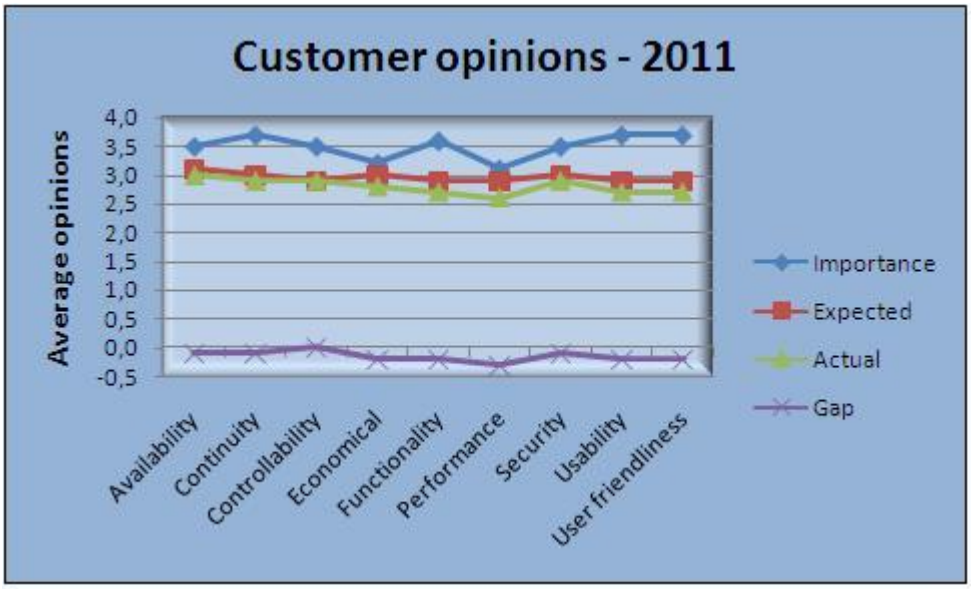


Figure 25 Performance of application for customer in 2011

Significantly, security and user friendliness are slightly improved and expectations on them are higher. The gap between the expected and experienced quality attributes for user friendliness is identical to the previous measurement but the expectations are no higher. This is an indication of improvement. Performance remains an issue and still needs to be addressed. The measurement status is red because even though expectations are higher the average difference between expected and actual experience is higher than for the previous measurement. In short, there is still room for improvement.

5.3.3 Financial Perspective

The EPIC contract is a seven year fixed price project. EPIC[4] has bundled its implementation and maintenance charges into one fee. This covers both costs for development and support for EPIC in a live system. The total fee does not include the cost of additional hardware specifically for EPIC or the implementation and maintenance costs for Spaarne. Finance mentioned that the hardware used for the old applications could not support upgrades to these applications and had to be changed. The maintenance costs for Spaarne, for example, helpdesk were deemed by Finance to be comparable to the costs for supporting the old applications and therefore no additional costs have been incurred.

The financial advantages of using EPIC are potential increase in turnover and savings in costs. A potential increase in turnover can be achieved if the more efficient capability of EPIC is utilized. An example of this is planning. A conservative assessment is slightly less than 1% increase on a yearly turnover. Costs savings can be achieved by not having to pay license fees for applications currently in use and by being able to borrow less money because a more efficient throughput of patients should make invoicing more efficient and timely. The EPIC solution provides the same (and more) functionality than is currently provided by two applications, that together cost more than EPIC. The finance department have a conservative estimate on cost savings due to borrowing less money and therefore paying less rent. A perception of finance is that this will only start to happen at the earliest at the beginning of 2010 due to time required by the end-user organization to learn how to use the application.

Identification of the KPI's and simulation of a change in effectiveness of these KPI's can be simulated without actual values. Any use of real data would also have to include guessed values because our verification of the framework requires a projection into the future. In which case, real cost savings and payments in the future cannot be known.

We have chosen to use three KPI's with the finance view; (i) DBC payments, (ii) cost savings due to more efficient patient care, (iii) cost savings due to making less medical mistakes. We have used percentages to reflect a projected and (simulated) actual percentage change for the years 2009, 2010 and 2011. All percentages are tied to the 100 percent reference in 2009.

Figure 26 shows the percentage change of turnover. In 2009 the turnover was slightly less than projected. Following on in both 2010 and 2011 the actual turnover was better than the projected. The measurement reporting colour for 2009 is therefore red and for 2010 and 2011 it is green.

[4] According to an interview with the finance department on 11/12/2008.

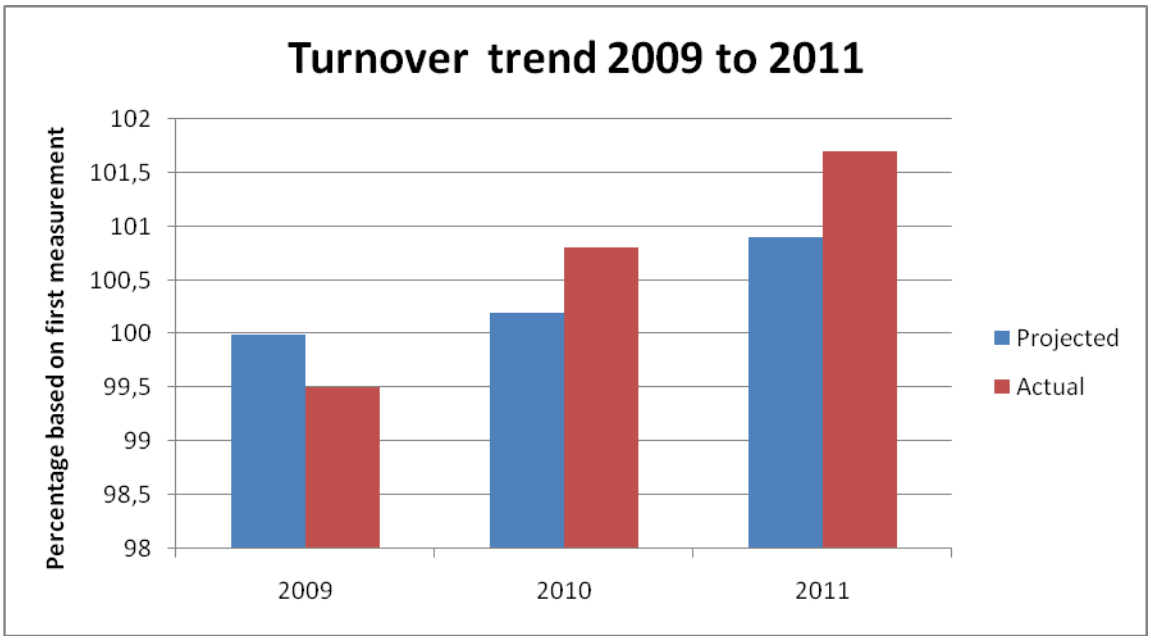


Figure 26 Percentage change in actual turnover

Figure 27 shows that more cost savings are expected from less borrowing in 2010 and 2011. The actual cost savings are less than expected in 2009 and slightly more than expected in 2010 and 2011. The measurement reporting colour for 2009 is therefore red and for 2010 and 2011 it is green.

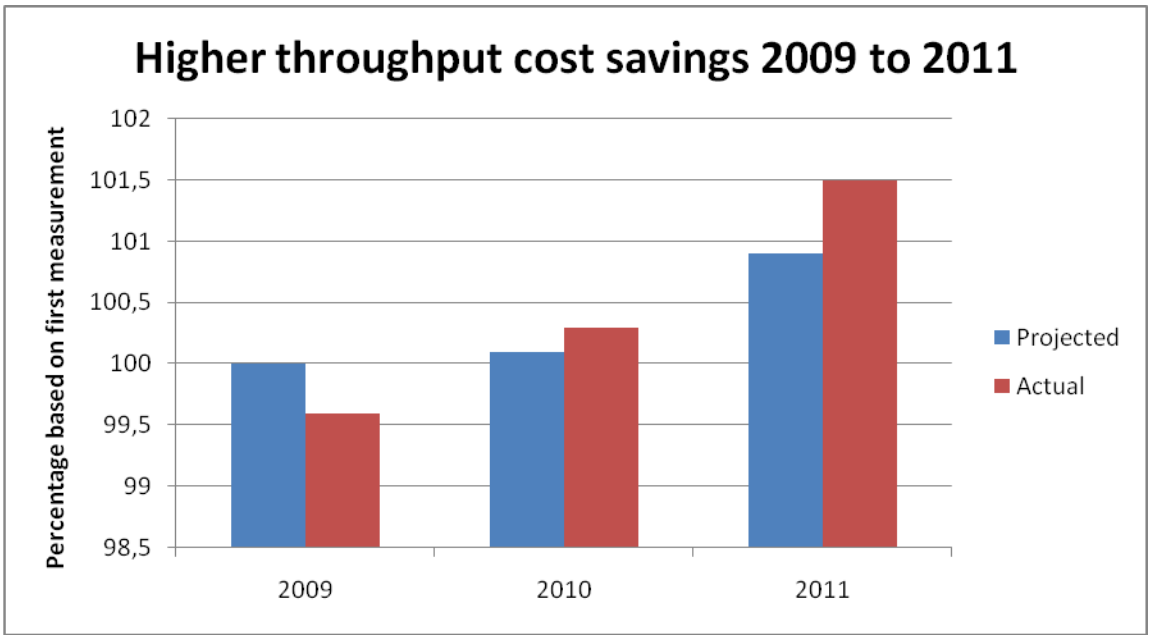


Figure 27 Percentage change in cost savings through higher throughput

Figure 28 shows that there were less than expected cost savings, as a result of less medical errors, in 2009 and slightly more cost savings than expected in 2010 and 2001. The measurement reporting colour for 2009 is therefore red and for 2010 and 2011 it is green.

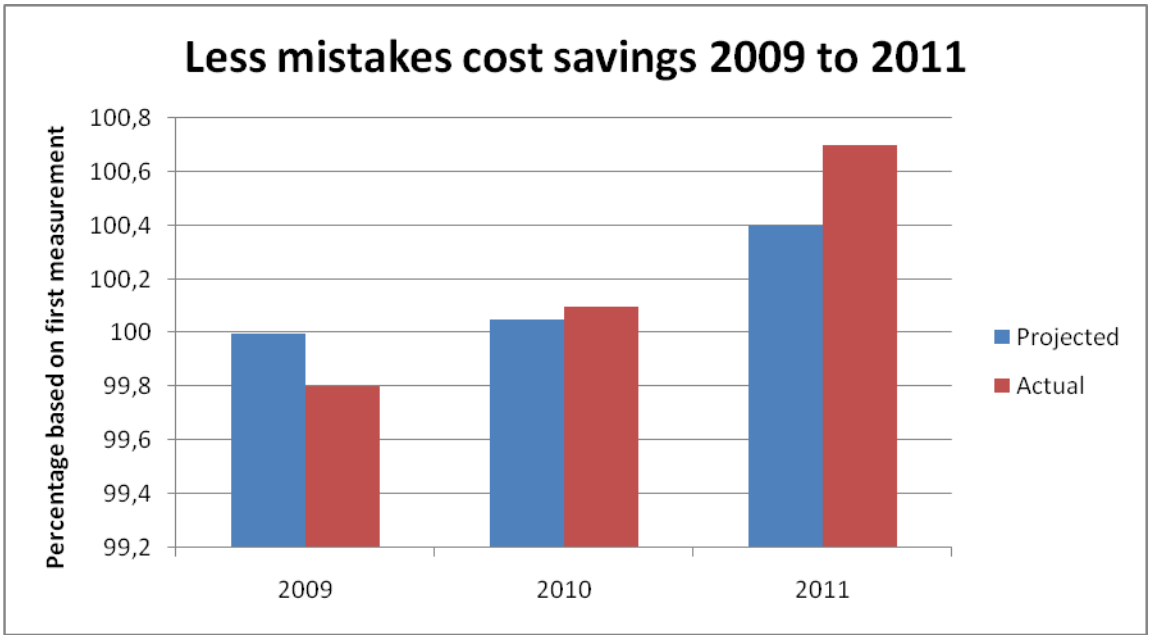


Figure 28 Cost savings percentage change from medical mistakes

5.3.4 Internal Process view

Treatment effectiveness is measured by gathering information on the core properties of treatments. Section 4.3.4 specifies the different types of DBC characteristics that can be measured. These characteristics are exactly the same as key performance indicators. This section describes a (simple) simulation of results for 2009, 2010 and 2011. We restrict ourselves to average treatment period, average percentage of risk on moment of diagnosis, average percentage of mistakes and success of treatment. Note that there is no control over the risk on moment of diagnosis.

Figure 29 describes the average treatment period for all DBC treatments in 2009 except for chronic illnesses where "Series 1" represents the average treatment time per month and "Series 2 represents the same value factored in with resources used. An example of resources[5] used could be, for example, the number of application transactions for the treatment instance. The average treatment time is 3.65 weeks.

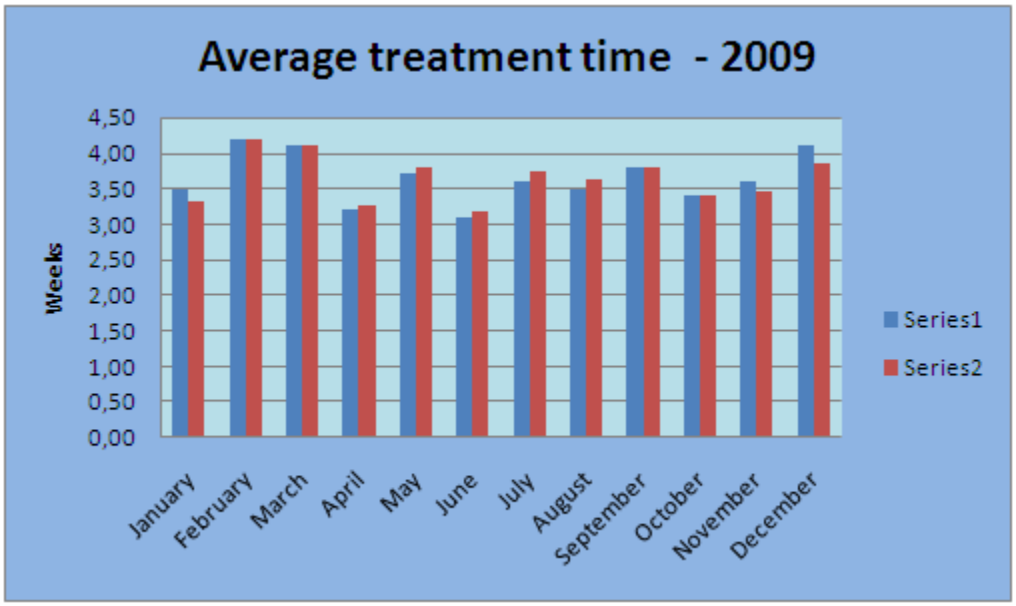


Figure 29 Average treatment time in 2009

The average percentage of successful treatments is 81.92% which translates to 79,68% after factoring in the average percentage of high risk cases and the average percentage of severe mistakes. Figure 30 describes the percentage of successful treatments together with a weighted percentage[6] which is factored together with the percentage of high risk and percentage of severe mistakes made. The weighted algorithm is:

[5] Average treatment + (((resources used – average resources used)/average resources used)*average treatment)

[6] Series 1 is the average percentage success over all DBC's. series 2 is the same value factored in with percentage of severe mistakes and percentage of high risk to patient.

weighted success percentage = ((100-percentage of high risk)/100)*((100-percentage of severe mistakes))/100* success percentage.

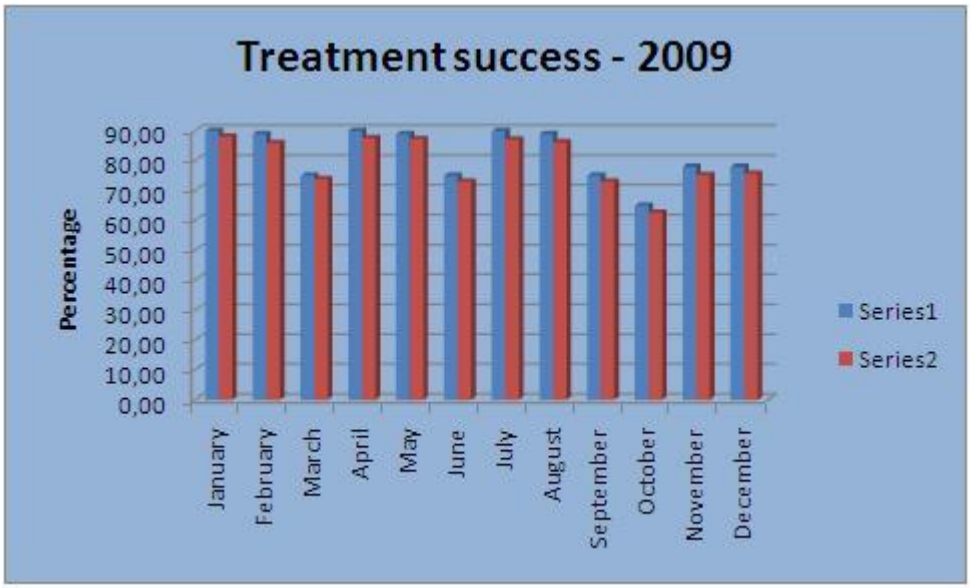


Figure 30 Percentage and weighted percentage of successful treatments in 2009

The measurement result for 2009 is red because these are the first measured results and no historical data is available on the average treatment time or the percentage of successful treatments.

Figure 31 describes the average monthly treatment time over 2010. Average treatment time, of 3.48 weeks, has been reduced in comparison to 3.65 weeks in 2009. “Series 2” is consistently less than “Series 1” in this same figure and shows that the resource usage is consistently more effective because the average for 2010 together with the average for 2009 are factored in[7].

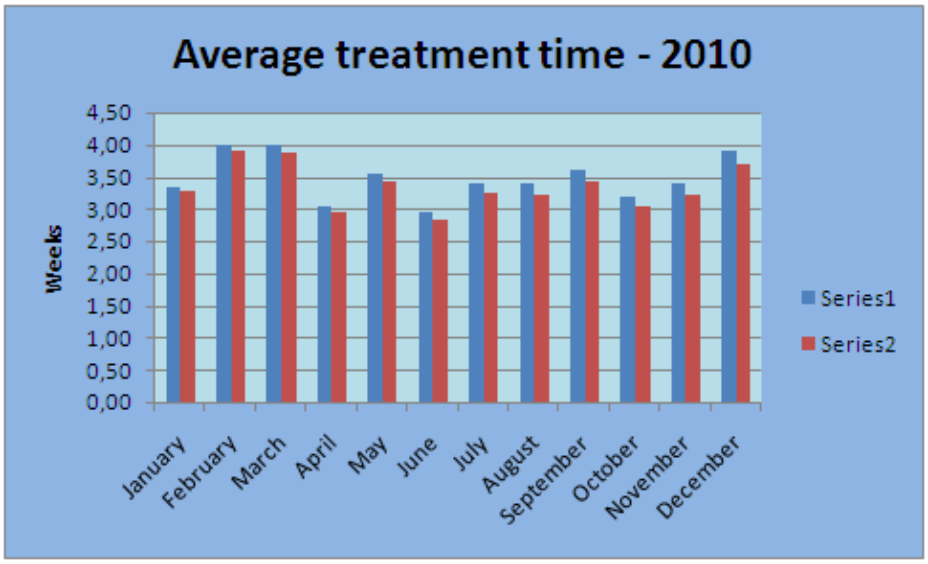


Figure 31 Average treatment time in 2010

Figure 32 describes the monthly treatment success. Success of treatment remains similar but the weighted average of success is slightly higher due to a decrease in severe medical mistakes.

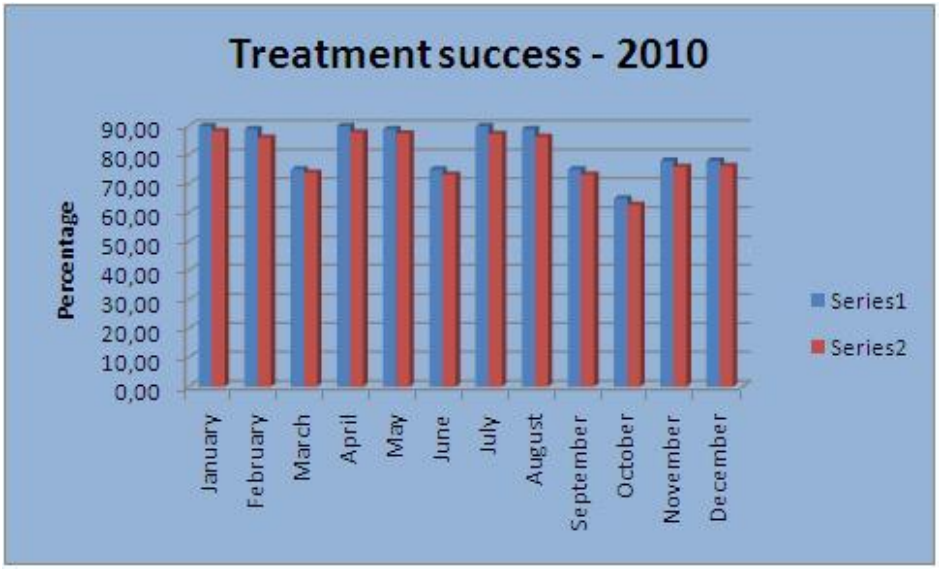


Figure 32 Percentage and weighted percentage of successful treatments in 2010

[7] Average treatment + (((resources used – average resources used from 2009 to 2010)/average resources used from 2009 to 2010)*average treatment)

Figure 33 and Figure 34 describe respectively the average monthly treatment time over 2011 and the monthly treatment success. Average treatment time, of 3.32 weeks, has been reduced in comparison to 3.48 weeks in 2010. Resource usage is again more effective because the average resource usage from 2009 and 2010 have been included[8]. Success of treatment remains the same but the weighted average of success is slightly higher than 2010 due to a further decrease in severe medical mistakes.

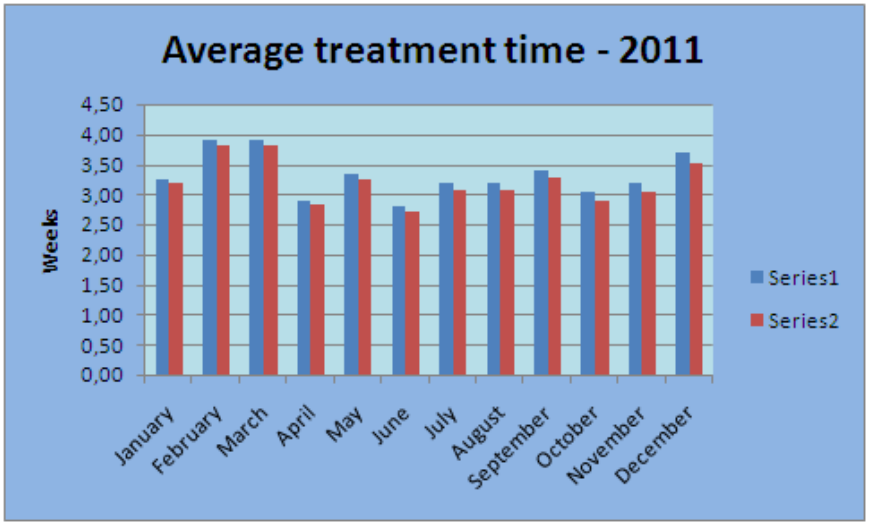


Figure 33 Average treatment time in 2011

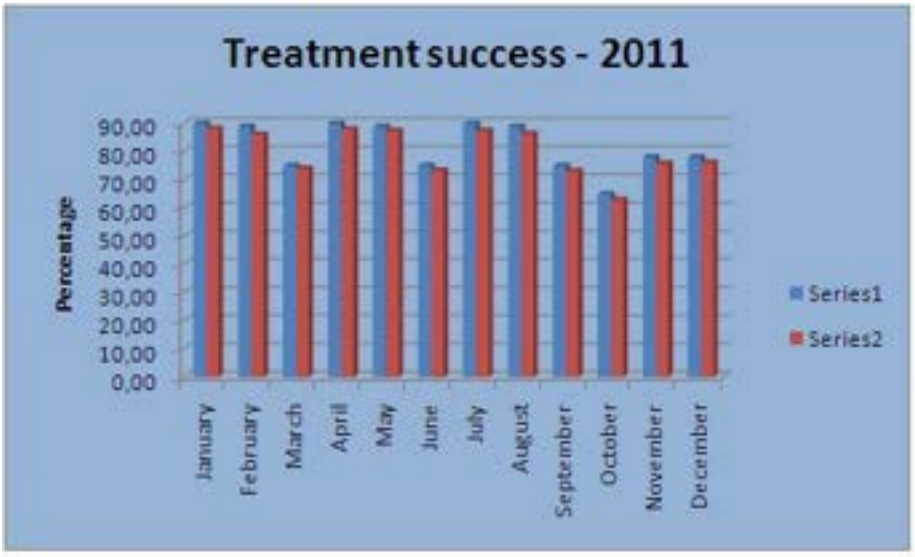


Figure 34 Percentage and weighted percentage of successful treatments in 2011

[8] Average treatment + (((resources used – average resources used from 2009 to 2011)/average resources used from 2009 to 2011)*average treatment)

Application quality is measured by gathering information on the number of incidents raised over a period of time and comparing this with the number that have been solved and are pending. Our simulation describes a situation whereby the number of application defects accumulates in 2009, see Figure 35, in such a way that even with a trend of less defects being generated the number of unsolved defects accumulates because each month less are being solved than those that are generated. The measurement status for 2009 is therefore red.

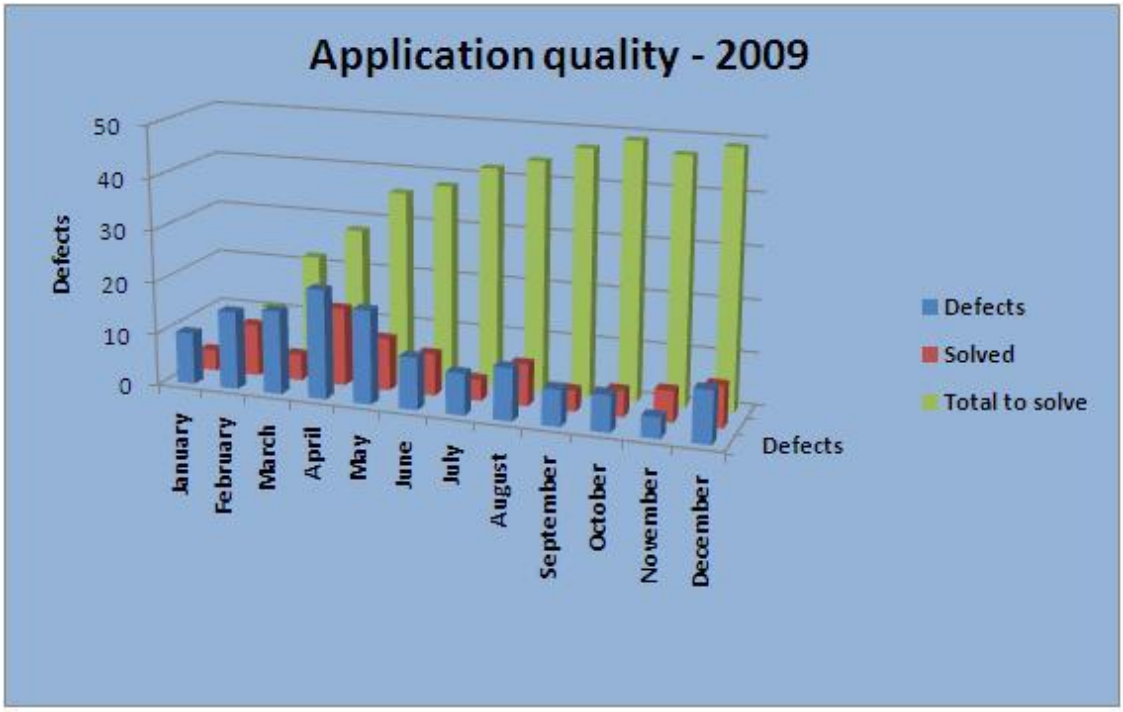


Figure 35 Application quality 2009

The result is that there is a backlog of defects to be solved at the beginning of 2010 together with the new ones generated, see Figure 36. The result is that more defects need to be solved than there are being generated. A trend can be seen of less defects being generated and less defects open to be solved. The measurement status for 2010 is amber.

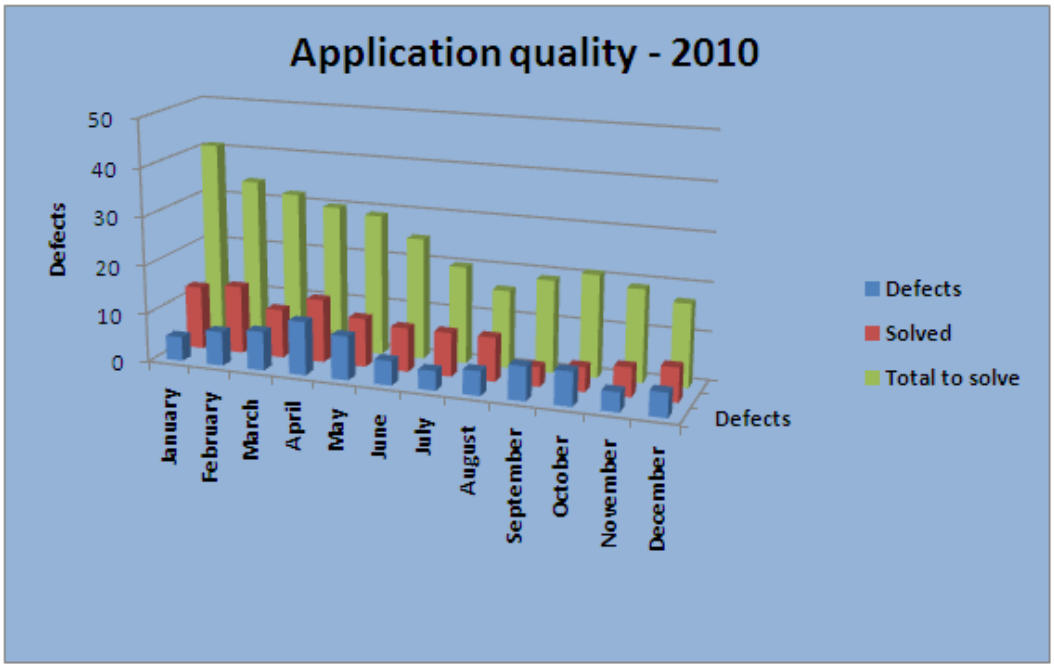


Figure 36 Application quality 2010

As with 2010, there is a backlog of defects at the beginning of 2011 but the total is less than in 2010. A trend can be seen of more defects beings solved than there are being generated. At the end of 2011 more defects are being solved than there are open. The measurement status for 2011 is green because the threshold of less than ten open defects has been reached.

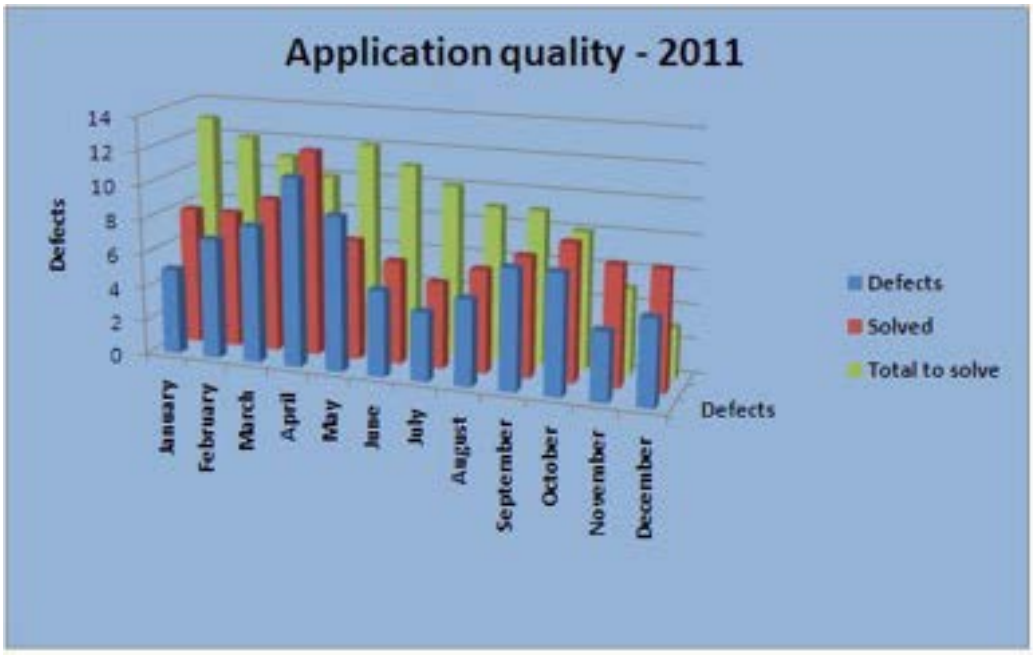


Figure 37 Application quality 2011

5.3.5 Learning and Growth View

Table 9 describes each of the quality attributes associated with training. Figure 38 describes the measurements for 2009. The objective attribute result shows that training in the application was considered of high importance and lot was expected of this training. Unfortunately the experience of using the training to achieve individual objectives with the application did not succeed. The application was extremely poor in supporting patient treatment. Recording of information was satisfactory. Experience of filing and reviewing information was less than expected. The measurement status for 2009 is red because this is the first measurement and more than one experience of training effectiveness is less than expected.

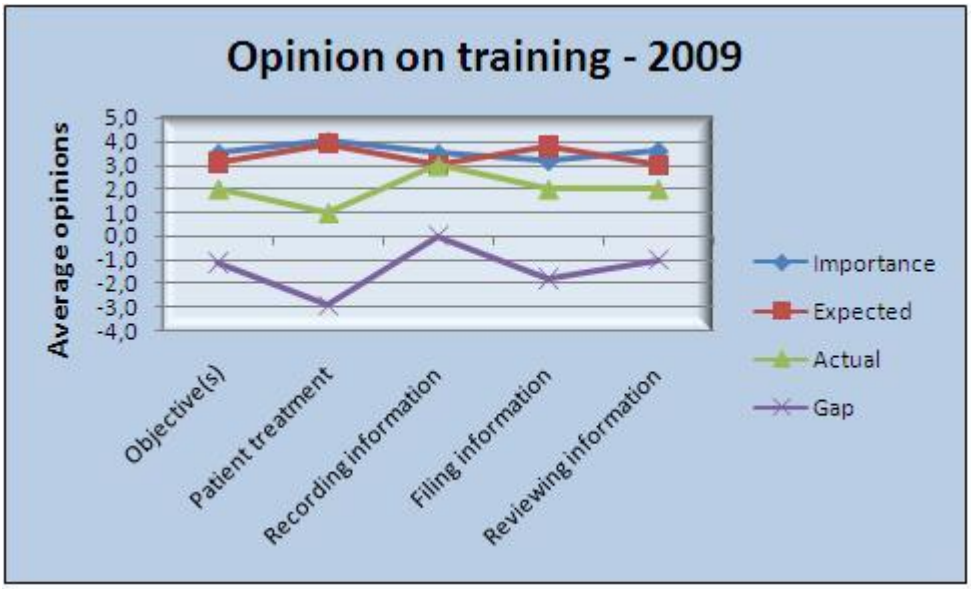


Figure 38 Effectiveness of training in 2009

Extra people in the end-user organization have been trained in 2010 and the results for 2010 are their opinions on the effectiveness of this training. Importance and expectations have remained the same in 2010. In general, the effectiveness of training seems to have improved although patient treatment is still a significant issue. The measurement status is amber because even though the difference between actual experiences of training effectiveness and the expected these differences are less than the measurement from 2009. Training in areas of patient treatment needs to be still significantly improved. The training needs to be tailored so as to help people meet their individual objectives. Filing and reviewing information training must be improved.

The effectiveness of training in 2011 is shown in Figure 40. It has been significantly improved because the gap between expected and experienced use of training is on average shorter. Filing and reviewing of information training has been addressed and is more effective. Training in the recording of information remains effective. Training tailored to individual objectives and patient treatment is no more effective but still needs to be improved. The measurement status is amber because, on average, actual experience of training is still less than expected but the average gap is less than the previous measurement in 2010.

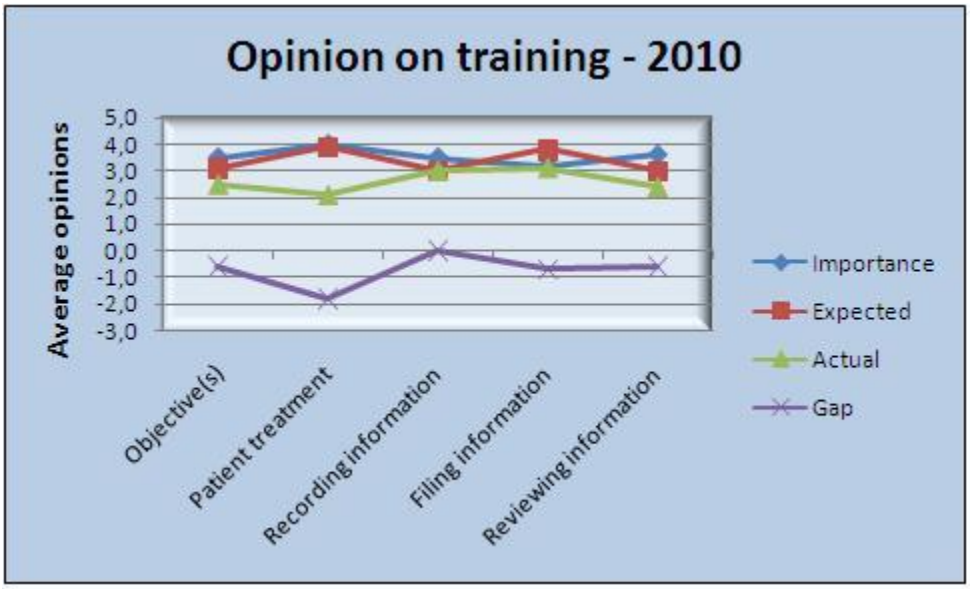


Figure 39 Effectiveness of training in 2010

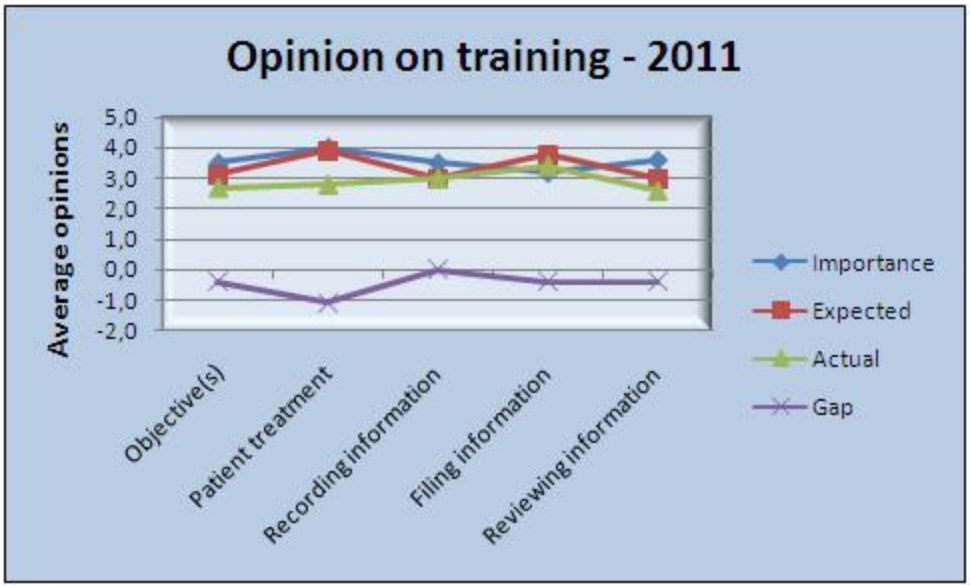


Figure 40 Effectiveness of training in 2011

A count of innovations could be included in this view by represented by EPIC enabling operational activities to be performed more efficiently. An example of this is the use of a laptop with a patient barcode interface and wireless connection to a server for remotely registering that a blood sample has been taken.

6 Validation of framework

To what extent is the chosen framework useful for correlating business benefits with the healthcare case study?

This chapter provides a validation[9] (see reference Appendix A) of the BSC Tower by one case study expert and two domain experts in IT investment and business benefits. Section 6.1 provides the result of validation by our sponsor in the form of answers to a questionnaire. Section 6.2 provides the results from the two domain experts.

6.1 Validation by case study expert

We have designed two kinds of questions in our questionnaire, multiple-choice and free-format. Our multiple-choice questions are focussed on the criteria of completeness, correctness, relevance and usability. The objective of these criteria is to form a basis for structured improvement in the BSC Tower if it was to be re-used in another case study or pilot. The free-format questions are used to find out additional information.

Completeness is a measure of fit-for-purpose capability of the framework. Correctness provides insight into the correctness of elements in the framework when data is used internally on them and when data is exchanged between these elements. Relevance is a judgement on the elements of the framework. Usability is a measure on the ability of the framework to be practically usable in its goal of systematically providing evidence of business benefits from IT investment.

The multiple-choice questions provide a three-point scale (sufficient, partially sufficient and not sufficient) so as to provide insight into the fit-for-purpose characteristics of our model.

We have not used a broader scale such as Likert (Wikipedia 2009) to rank answers because our questionnaire has only been answered by one person and not by a sample population. Statistical analysis, with averages and standard deviation, did not have to be performed for the same reason.

The following sub-sections, 6.1.1 to 6.1.4 contain the answers from our sponsor ('V' for choice from multiple-choice and italics for her comments). Our sponsor also mentioned that she is interested in operational KPI's that are related to strategic decisions and operational KPI's that are related only to operational decisions.

[9] Is it fit for purpose?

6.1.1 Completeness

Does the BSC Tower layered approach provide a mechanism for correlating strategic investment and strategic business goals with operational reality? *Comment by case study expert: strategic goals might often seek to change day to day operational reality, so the operational key indicators might have to change due to the strategic investment/decision.*	Sufficient	Partially Sufficient	Not sufficient
		V	
Does the BSC Tower view (customer, financial, internal processes, Learning and Growth) approach provide a way to correlate intangible with tangible variables?	Sufficient	Partially Sufficient	Not sufficient
	V		
Can the BSC Tower be used as a basis for reporting on continual improvement in the healthcare domain? *Comment by case study expert: the BSC is based on one of the strategic decisions. Of course the hospital is focussed on many more strategic directions and therefore it is not the sole basis for improvement.*	Sufficient	Partially Sufficient	Not sufficient
		V	

6.1.1 Correctness

Does the BSC Tower layered approach provide a basis for defining all intangible and tangible variables that need to be measured?	Sufficient	Partially Sufficient	Not sufficient
	V		
Is the description in each BCS tower level (strategic, tactical, and operational) correct?	Sufficient	Partially Sufficient	Not sufficient
	V		
Are the measurement variables that are defined in the tactical view, for both investment and business benefits, correct?	Sufficient	Partially Sufficient	Not sufficient
	V		

6.1.2 Relevance

	Sufficient	Partially Sufficient	Not sufficient
Are the BSC Tower views relevant to providing a systematic recognition of all intangible and tangible variables?	V		
Does the BSC Tower strategic level provide a mechanism for providing input at the decision maker's level?		V	
Does the BSC Tower tactical level provide a mechanism for identifying KPI's in healthcare?	V		
Does the BSC Tower operational level provide a mechanism for reporting on improvements in KPI's and correlating these back to the investment? *Comment by case study expert: since the better part of the KPI's is of an intangible nature it is very difficult to correlate it against the investment made.*		V	

6.1.3 Usability

Can the BSC Tower strategic level be used for linking investment with business benefits in the case study? *Comment by case study expert: since test data were used we got an impression of the effect of the BSC Tower, but have not seen it translated towards operations in our own hospital.*	Sufficient	Partially Sufficient	Not sufficient
			V
Can the BSC Tower tactical level be used for defining all variables (investment, tangibles, intangibles, business benefits, KPI's) that need to be measured? *Comment by case study expert: since test data were used we got an impression of the effect of the BSC Tower, but have not seen it translated towards operations in our own hospital.*	Sufficient	Partially Sufficient	Not sufficient
		V	
Can the BSC Tower operation level be used in the case study for measuring and reporting on improvements in the business benefits from investment?	Sufficient	Partially Sufficient	Not sufficient
	V		
Can the BSC Tower be used for providing evidence of business benefits and return on investment? *Comment by case study expert: since the better part of the KPI's is of an intangible nature it is very difficult to correlate it against the investment made.*	Sufficient	Partially Sufficient	Not sufficient
		V	

6.1.4 Free-format questionnaire

In what areas can the BSC Tower be improved or extended for use with the case study? *Comment by case study expert: We will need to translate all KPI's from the test data to actual KPI's for our own hospital (what is measured/can be measured over a number of years).* *To offset the improvements to the actual investment it would be interesting to put "face values" in EURO's on the intangibles as to approach whether the investment is paid back by them. E.g. a patient with a complication on average costs us EUR ……for repairing processes. Thus is a decrease in complications EUR…….. on paid back investments.*
Which mistakes in the BSC Tower need to be rectified before using with the case study? *Comment by case study expert: In the version I commented on the field of innovation was not covered.*
What recommendations do you have for tailoring the BSC Tower for the case study? *Comment by case study expert: See above.*
What recommendations do you have for using the BSC Tower in the case study? *Comment by case study expert: See above.*

6.2 Validation by domain experts

One academic expert provided encouraging feedback. “A strong thorough piece of research with very good case material. I am sure the way you have performed this sets you up well for doing good consultancy in the area anywhere and not just in health care. It is close to the sort of thing we were advocating say in our book delivering IT and e-business value but it is very nice to see it being actually done and well! I am sure you will score highly with this piece of work and it needs no criticism from me p.s. my co-author Sara Cullen has a new book out in May on The Outsourcing Scorecard - maybe a further application for you?” Unfortunately, although good for the ego, this feedback could not be constructively used.

The final academic expert, who also has consultancy experience in healthcare, provided some very constructive criticism (see italics for our answers, which have been accepted as correct by this expert):

- “Had we thought about using simultaneous cost calculations between hospital departments? ” – *We have not used ABC costing because it is not used in the case study financial department.*
- “For IT investments and costs, usage is the first step, I like to investigate whether the users have made any changes to their behavior and if that change is reflected in the metrics.”
- “ I liked the review of various models and your integration of the key concepts.”
- “Clarify where the data, including for projections, comes from (interviews, surveys).”
- Validation of framework:
    - “Who are the respondents of the survey? If hospital or business practitioners then I am concerned that they may not know what the meaning of models/frameworks such as BSC or KPI's.” – *The respondent is my sponsor who freely uses the terms BSC and KPI.*
    - “Why a 3 point scale? They can just as well answer a 7-point or 10 point scale which is better for analysis.”
    - “ Some of the questions are too long and compound (i.e. capture more than one construct) which threatens validity of the responses. For example 6.1.3 question … What if the respondents agree with one and not the other? They can pick partially sufficient but you would not know which one is sufficient or whether the respondent agrees that both are partially sufficient?”
- “Section 7. Please clarify how you arrived at these conclusions.”

7 Conclusions from the case

Our main focus here is the applicability of the BSC Tower for the case study, described in section 7.1, because this determines the degree at which it could be first used. We provide a concise answer to our research questions in section 7.2 because a more complete answer has been provided in the preceding chapters.

7.1 Usefulness of the BSC Tower

Our hypothesis is our new framework the BSC Tower can be used on the case study. Verification of the BSC Tower in chapter 5 does support the idea that it is possible to map investment to expected business benefits at the strategic level and use the resulting information to define and measure the variables that represent these strategic entities at the operational level. This link enables us to use strategy and operational triangles for comparing the effectiveness of strategy and operations. The result is two fundamental benefits to the business. Firstly, measuring operational variables at intervals provides insight into improvements in operations through an analysis of the comparison of current benefits against cumulated investment and by comparing current status against historical status. Secondly, comparing the current operational triangle against the latest strategic triangle provides insight into the level of consistency between strategy and operations – are we doing things that we should not be doing (strategy wrongly implemented), are there unexpected potential benefits (operational information impacting on a change in strategy, are we on course (strategy correctly implemented). The results from our test data support this hypothesis.

Validation in chapter 6 does indicate that, based on characteristics of a working model, our BSC Tower is correct, partially complete, partially relevant and partially usable as a framework for measuring the business benefits against investment in IT for the case study.

The strategic, tactical and operational levels are considered to be correct for the case study and provide a basis for defining the intangible and tangible variables that need to be measured. The investment and business benefit variables that have been defined for our test data are considered to be correct.

The BSC Tower is complete and therefore fit-for-purpose for the case study because it provides the ability to correlate strategic investment and business goals with operational reality, a way to correlate intangible and tangible variables at the operational level and therefore supports a continual improvement approach in healthcare. Nevertheless, there are other strategic decisions that are not related to IT investment. Therefore the BSC Tower is not all encompassing in its support of continual improvement. Changes in strategic decision might also require the measurement of different operational variables.

The BSC Tower is relevant for the case study because it can be used for systematically recognising intangible and tangible variables and therefore identifying KPI's in healthcare. It does provide a mechanism for reporting on improvements in KPI's and correlating these back to the original investment and it therefore does provide a mechanism for input to the strategic decision process. It does not support the strategic decision process outside IT investments. There is a perceived difficulty of correlating KPI's with investment because of the intangible nature of

KPI's. We have provided some examples, in our verification of the model, of translating intangible variables to tangible, quantitative information.

The BSC Tower is usable for the case study because it can be used for defining all variables that need to be measured and, at the operational level, measuring and reporting on improvements in business benefits. An impression of the usefulness of the BSC Tower has been provided with the verification from test data. A more accurate measure of its usefulness could be provided by translating the test data used to real case study operational data.

In summary, the BSC Tower has potential to be used as a measurement framework with the case study.

7.2 Answers to research questions

7.2.1 Answers to research sub-questions

What are the recent developments within healthcare in Holland and Europe that are related to strategic investment in IT and the business benefits from its use?

The recent developments within healthcare in Holland and Europe show that there is a common strategy at European community level and the Dutch government is behaving consistently with this strategy. The case study exists partly as a result of the Dutch government strategy. Specifically this is about the need to invest in IT to support the necessary business processes and flexibility for the future. The BSC Tower by being feasible for the case study is therefore potentially feasible for equivalent cases in healthcare at other Dutch locations than the case study.

Which performance measurement models can be used for correlating IT investment with business benefits?

There are no models that can be used as a framework, by itself, for measuring and correlating IT investment with business benefits.

Which framework can be used for correlating business performance with IT investment in a healthcare case study?

We have created the BSC Tower because we have not found a model that can be used by itself as a framework for measuring and correlating IT investment with business benefits. The BSC Tower addresses this missing link.

To what extent is the chosen framework useful for correlating business benefits with the healthcare case study?

Our conclusion from a verification on the BSC Tower is that it could be used on the case study but a significant amount of, not insurmountable, work needs to be performed to achieve this with the aid of a BI solution. The trick that needs to be investigated further is deciding what real-world information really needs be measured from a potentially vast amount of real-world data. This issue is supported by the validation comment of the need for translating the test data to real-world case study operational data. The extent of our BSC Tower is therefore a feasible first step and a significant leap.

What framework is appropriate for providing continual and systematic insight into the business benefits from an investment of IT?

The BSC Tower.

8 Reflection

"Something was there, we did not know what it was but we had to find it" has been the driving force behind this thesis.

The BSC Tower does provide a basis for continual measurement and assessment of business success from investment in IT. Our research does show that it is possible to systematically measure both intangible and tangible variables, place these variables in their context and correlate results. It does show that tangible variables can be measured at source, immediately when their state (value) changes and therefore indicates that the measurements of tangible variables are frequent. Measurement of tangible variables should be provided automatically by IT.

Intangible variables can only be measured in a structured qualitative way. By their nature, intangible variables cannot be measured every time their state changes and their measurements are therefore infrequent. Non-manual measurement aspects of intangible variables should be provided automatically by IT. An example of this is the provision of a questionnaire on the company Intranet where the data is automatically combined and correlated and reported on together with its statistical significance.

The mismatch of difference in time between tangible and intangible results, due to the difference in frequency of sampling, is an unknown effect. It might be useful to initiate an intangible measurement, for example, if something has significantly changed in tangible results. An ex post validation with a pilot study is a useful exercise for further validation and understanding of our framework.

Such things as stakeholder analysis, the correlation between IT investment and business benefits in the strategic level and the definition of variables to measure in the tactical level are all activities that need to be performed by an expert (person).

Measurement and reporting in the operational level should be provided by some form of business intelligence, management reporting tool. This highlights the importance of knowledge management with the framework because of the need for efficient and effective measurement, reporting and facilitation of analysis.

In summary, there are two things missing. The BSC Tower can only be proven to be a useful framework by using it with real-world data. The challenge of filtering from a potentially vast amount of data dictates that an investment in a BI solution is required even if the next step is restricted to a pilot study that uses only a subset of the available data as its data source.

9 Conclusions

The original idea was to provide from existing theory an answer to the productivity paradox by providing a measurement model that could be validated against a case study. Our intention was to use a theoretical model that described how exactly to perform measurements on IT investment and business benefits and correlate these two types of variable. Unfortunately, we could not find this model. We found a lot about what to do, at a high level, but not how to do it. We have tried to address the how.

We have created the BSC Tower as an answer to this problem. It is a new a framework for comparing and correlating business benefits with investment in IT. We do not consider the BSC Tower to be state-of-the-art because it has been created from existing models. Nevertheless, we have selected only the best parts of these models.

The BSC Tower provides the ability to analyse the correctness of strategy and operations because the strategy triangle can be compared against the operational triangle. The BSC Tower provides the ability to measure improvements in operational activities and compare these against the original IT investment because it provides a structured way of defining and measuring these variables. The three-tiered (strategy, tactical and operational) layers of the BSC Tower provide a way of mapping strategic with operational information.

Further refinement of the BSC Tower can only be achieved by re-using it on real-world data. Potential follow-on work is therefore a pilot study with a restricted scope on the type and amount of data to gather but with an objective of going deep enough at the operational measurement level so as to be able to realistically compare operational measurements against the strategic level IT investment and expected business benefits. The result of such a case study could be fed back into an improvement of the BSC Tower.

List of abbreviations and terms used

Abbreviation	Description
EPIC	http://www.epicsystems.com/ is a provider of healthcare software. The solution for Spaarne is the EPIC patient logistics application which is in use in approximately one in four of all hospitals in the United States.
BSN	http://www.nictiz.nl/, the *Burgerservicenummer* (BSN) – translated to citizen service number in English – is a unique identifier of medical history for patients in the Netherlands. It has been designed to address the problem of maintaining electronically, medical information of citizens of the Netherlands, in a consistent and unique manner.
CMMI	Capability Maturity Model Integration.
Cobit	Control Objectives for Information and related Technology
IT	Information Technology
BSC	Balanced Scorecard
SWOT	Strengths, Weaknesses, Opportunities, Threats
DBC	Diagnose-BehandelingCombinatie, the medical treatment path for providing healthcare to patients.
SMART	Smart, Measurable, Applicable, Realistic and Timely
TOC	Theory of Constraints
TQM	Total Quality Management

Term	Description
Ex ante	Latin: meaning before the event.
Ex post	Latin: meaning after the event.

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Appendix A - Definition of core concepts

Business benefits

Our context is about business benefits from an IT-enabled change. According to (Peppard and Ward 2005) the "benefits to an organization from IT-enabled change essentially emerge from three causes: either *stopping* doing activities, doing what has always being done but *better* (i.e., cheaper and/or faster), or doing completely *new* things". Our case study is about business benefits related to doing completely *new* things combined with what has been done but *better*.

Cash flow

This is the movement of money into and out of a business, as a measure of profitability, or as affecting liquidity.

Continual and systematic measurement

Our opinion is that any measurement of the business benefits from an IT investment must be performed continually – not every second of every day until eternity but at regular intervals – and systematically. Together continual and systematic measurement mean that a measurement can be performed regularly in the same way so that new measurements can be accurately compared and correlated against old measurements. This will provide an aid to continual (as opposed to continuous) improvement.

Criteria

We have chosen to use the definition of criteria from (Aalders 2004) because of the need to clarify the difference between measured result and the performance drivers that enable the results. The performance drivers are those inputs or characteristics that the provision of an IT system must have and are therefore the critical success factors. Criteria are the attributes that we can measure and therefore they are used to provide the evidence of critical success factors being achieved.

Data

Data is the bare storage of information that does not by itself provide meaning.(Rowley 2007)

Evidence

(1990) describes evidence as "the available facts, circumstances, etc supporting or otherwise a belief, proposition, etc, or indicating whether or not a thing is true or valid". We define evidence as "the information that provides answers to who, what, when and where to enable a human being to know if the benefits to the business have passed a pre-determined threshold or these benefits are improving or decreasing".

Information

Is data that is processed to be useful and provides answers to "who", "what", "when" and "where" questions.(Rowley 2007)

IT system

An IT system is the architectural set of network components and associated communications, the set of computers and operating systems and the application software. The application software can be specific to the business domain or generic for all business domains.

Knowledge

(Rowley 2007) "Knowledge is know-how, and is what makes possible the transformation of information into instructions. Knowledge can be obtained either by transmission from another who has it, by instruction, or by extracting it from experience."

Pay back

(Remenyi, Money et al. 2000) specifies this as the "amount of time, usually expressed in years and months, for the original investment to be repaid by the cash-in flows". We define pay back as the total set of intangible and tangible benefits to the business that can be classified as being equal to the total investment. The payback time is therefore the time when the total sum of intangible and tangible benefits is equal to the total investment.

Strategic investment in IT

We have used (Renkema 2000) as a reference. Strategic investment in IT is an investment in IT that is decided upon at board level from a business perspective so as to enable future business strategies. An example is the introduction of substantial business improvements.

Policy, strategy, tactics and operations in business

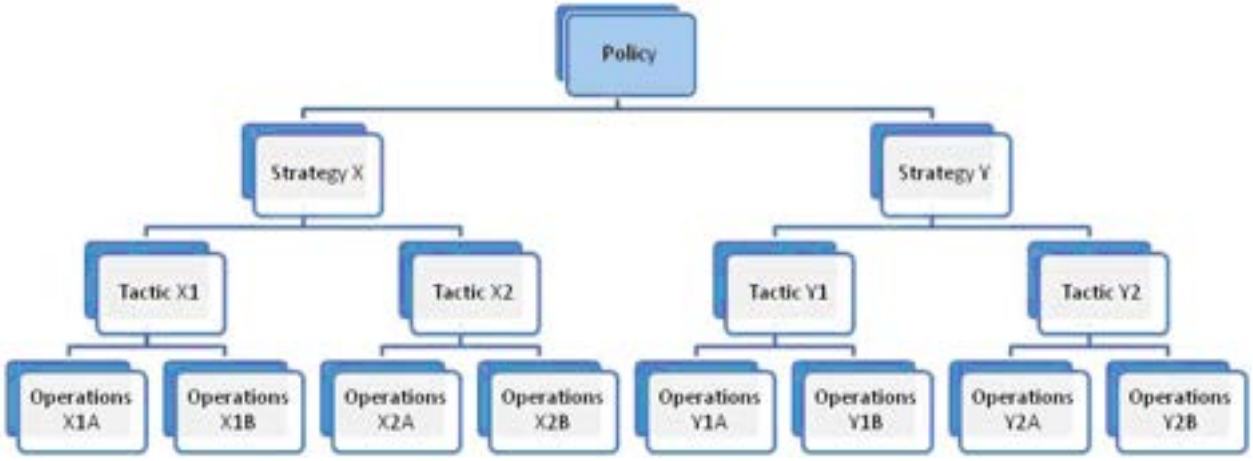

Figure 41 The Policy to Operations hierarchy

Policy has been derived from the Greek word "politeia" and latin word "politis" meaning polished or clear. It is the statement or general understanding which provides guidance in

decision making to members of an organization in respect to any course of action. Strategy means a long-term goal and is taken from the Greek word that means “army leadership”. Tactics on the other hand means a short-term plan and comes from a Greek word that means “science of arrangement” (of an army). Tactics defines how to set up operations, where operations are instances of a tactic. Policy, strategy, tactics and operations form a one-to-many hierarchy as described in Figure 41. Note that operations (not in the medical sense) maps to daily (instances) activities of a tactic.

In the context of healthcare, an example of policy might be that is that Dutch citizens that are insured will get the best medical treatment available independent of the cost of the treatment or the wealth of the citizen. Following on from that a strategy might be to specialize in a number of particular treatments. A tactic maybe the organizing of the medical and support staff, who focus on one type of treatment, so as to optimize the treatment chain and thereby optimize throughput, decrease costs and maximize the value of the treatment. Operations (again, not in the medical sense) are simply the physical activities required to execute the treatment.

Testing, Validation and Verification

We have used an ISO 9000 reference (9000 2009) as the basis for our definition of testing, verification and validation. In summary, verification is the process of evaluating that our model complies with the intended requirements. Validation is the process of evaluating that our model is fit-for-purpose with the case study.

Appendix B - Models selected

Table 2 Model selection matrix

Model	Strategic Requirements			Tactical Requirements						Operational Requirements		
	Insight into external factors	Complete view of business	Map strategic decision to IT investment	Insight into financial costs and income	Analyze organization	Effectiveness of internal processes	Quality of application	Effectiveness of training	Customer satisfaction	Non-automatic data gathering	Automatic data gathering	Reporting
SWOT Analysis	√	x	x	x	x	x	x	x	x	x	x	x
Balanced Scorecard	x	√	x	x	x	x	x	x	x	x	x	x
Benefits Management	x	x	√	x	x	x	x	x	x	x	x	x
Financial views	x	x	x	√	x	x	x	x	x	x	x	x
Stakeholder Analysis	x	x	x	x	√	x	x	x	x	x	x	x
Ranking and scoring survey	x	x	x	x	x	x	x	√	√	x	x	x
Team learning	x	x	x	x	x	x	x	√	x	x	x	x
Training evaluation	x	x	x	x	x	x	x	√	x	x	x	x
Real options	x	x	x	x	x	x	x	x	x	x	x	x
Performance Prism	x	x	x	x	x	x	x	x	x	x	x	x
4 P's model	x	x	x	x	x	x	x	x	x	x	x	x
Five forces	√	x	x	x	x	x	x	x	x	x	x	x
Portfolio management	x	x	x	x	x	x	x	x	x	x	x	x
Risk Management	x	x	x	x	x	x	x	x	x	x	x	x
Organizational perspectives	x	x	x	x	x	x	x	x	x	x	x	x
Strategy map	x	x	x	x	x	x	x	x	x	x	x	x

Model	Strategic Requirements			Tactical Requirements						Operational Requirements		
4-phase EIAC	√	x	x	√	x	x	x	x	x	x	x	x
CMMI	x	x	x	x	x	x	x	x	x	x	x	x
Cobit	x	x	x	x	x	x	x	x	x	x	x	x
VALIT	x	x	x	x	x	x	x	x	x	x	x	x
EFQM tool	√	x	x	x	x	x	x	x	x	x	x	x

Appendix B.1 - Balanced Score Card

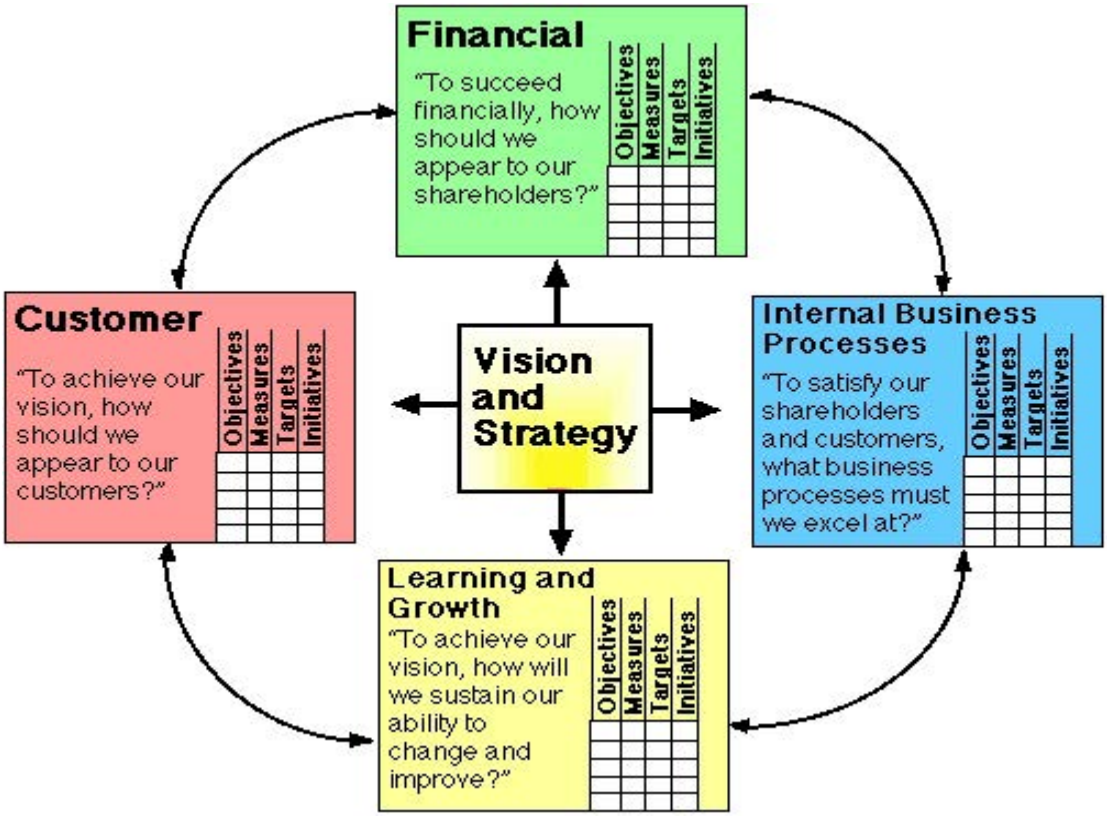

Figure 42 Balanced Scorecard

The conclusion of our research is that the Balanced Scorecard (BSC) from (Kaplan and Norton 1992) is the only model that provides a total view. This view is provided from four different perspectives; see Figure 42, each perspective being built up with four different parameters.

The columns in Figure 42 are defined as follows. Objective is the statement of what the organization wants to accomplish. Measure is the quantitative representation of a strategic objective. Target is the value for each strategic measure that the company is trying to achieve. Incentive is a program designed to help the organization achieve its objective.

Appendix B.2 - Stakeholder Analysis

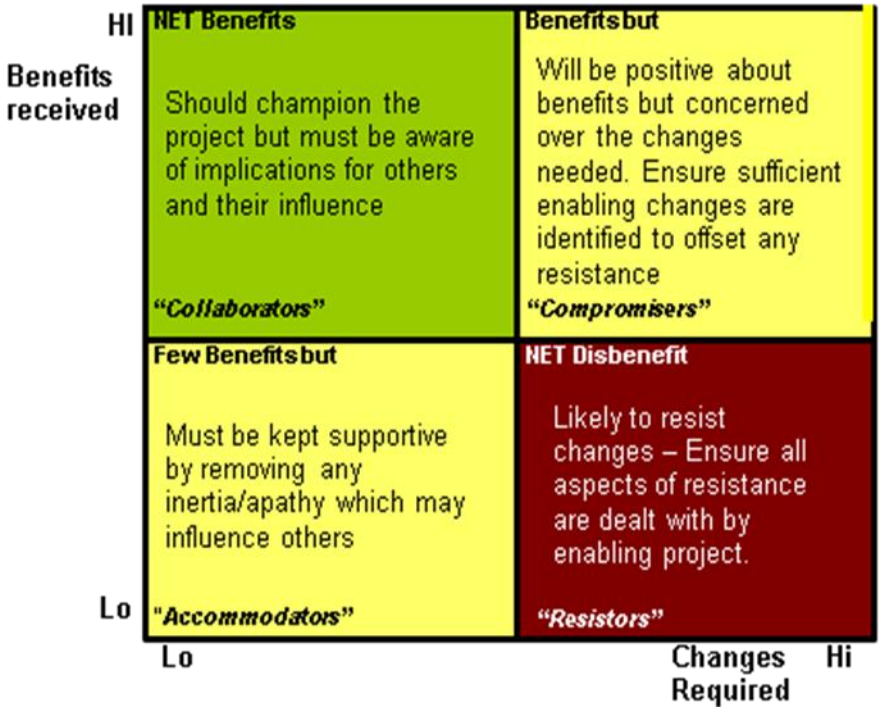

Figure 43 Stakeholder analysis

It is important to know the opinions of benefits from change by stakeholders because any issues that need to be addressed can be prioritized and worked on after the opinions have been analyzed. Typical issues that need to be addressed are ones where people will resist change.

We have used the '*stakeholder analyses summary matrix*' developed by (Benjamin and Levinson 1993). Using this technique the stakeholder situation is summarized in a 2x2 matrix based on the relative amount of change required by or affecting a stakeholder or stakeholder group ('the pain') and the extent of benefits received by the same stakeholder ('the gain').

Stakeholders in the high benefits, low change required quadrant (*"Collaborators")* should champion the project but must be aware of implications for others and their influence. Stakeholders in the low benefits, low changes (*"Accommodators")* quadrant must be kept supportive by removing any inertia/apathy which may influence others. Stakeholders in the high benefits, high changes quadrant (*"Compromisers")* will be positive about benefits but concerned over the changes needed. Ensure sufficient enabling changes are identified to offset any resistance. The stakeholder in the low benefits, high changes quadrant (*"Resistors")* will likely resist the changes. This model helps to identify which stakeholders or stakeholder groups need most attention. The stakeholders who fall in the high change segments should be analyzed in more detail.

Appendix B.3 - Benefits Management

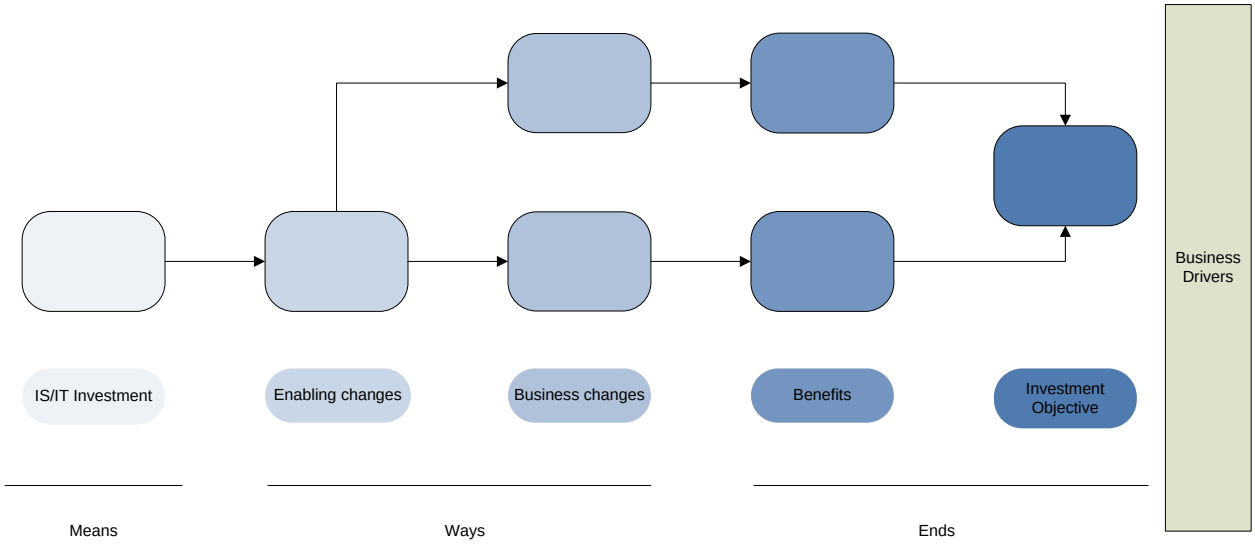

Figure 44 An example of a Benefits Dependency Network (BDN)

One example for Spaarne is a more people centric approach to healthcare which is being driven more from changes in Dutch law related to patient identification (BSN) and treatment (insurance related). This people centric approach classifies both the internal organization and the external customers (patients) as important. Another example of business driver is a result of the inflexibility of the current solution to support changes. It is not possible to easily make changes in the information system as a result of external forces with the result that a new solution has been required.

An (investment) objective is the link between a business benefit and the business driver and is the return on investment evidence for management. An example of investment objective is the treatment of more patients, better and sooner, now and in the future which addresses the driver for a more patient focussed procedural approach.

A business benefit is what is actually needed to be seen within the working organization in terms of advantageous results from an investment so that the investment objective will be met. Examples related to the previous investment objective example are direct statistical evidence from the information system solution that more patients are being treated quicker with less incorrect use of medicines.

The business change is the change in the business output as provided by the working organization and information system together. Examples of this related to supporting the business benefits are a decrease in patient treatment cycle time and more accurate business data.

Enabling change is a combination of what needs to be provided within the business process execution (people or information system) and what needs to be provided with respect to inputs to the business processes. Examples of this to support business change are a more efficient application that provides an improvement in supporting the treatment path together with a change

in the organizational way of working to optimally use this application and consequently less mistakes in data entry by people and information system working more efficiently together.

IS/IT investment is the investment in providing a solution to enable changes in the way of working and consequently enables a business change. Examples of this are an investment in designing, building and configuring a software solution for (i) patient treatment that addresses the patient care path and (ii) easy to use data entry which contains intelligence to minimize the chance of entering invalid data.

We think that it would be useful to start with a BSC analysis and use this higher level analysis on a benefits management BDN for each BSC view. The reasons for this are that BSC has not been designed for an analysis of IT and does not go into enough detail and benefits management does not provide the different helicopter contextual business views that BSC does but benefits management does provide a mechanism for linking IT and business. Benefits management does not directly specify which kind of information needs to be gathered, correlated and analyzed. We therefore need to expand our model review.

Appendix B.4 - Financial view

Activity Based Costing (Collier 2006) (or ABC) uses the concept of cost pools and cost drivers to calculate the cost of an activity or process instance. The cost pool is the total cost of all activities. The cost driver is the total number of process instance outputs. Dividing the cost pool by the cost driver gives an average of the cost for each activity.

Cash Value Added (Collier 2006) provides a weighted adjustment because it is the ratio of NPV divided by the initial capital investment. This provides a more realistic comparison of NPV's because the adjustment by the initial investment results in values that can be compared.

Discounted Cash Flow (Collier 2006) (or DCF) is identical to NPV.

Internal Rate of Return (Collier 2006) (or IRR) determines by trial and error the discount rate that will produce an NPV of zero. This provides a comparison of different investment possibilities because the different cash flows are presented as an effective interest rate. The highest internal rate of return is preferred as long as the rate exceeds the cost of borrowing.

Net Present Value (Collier 2006) (or NPV) discounts future cash flows to their present value and compares the present value of future cash flows to the initial capital investment.

Return On Investment (Collier 2006) (or ROI) is the rate of return achieved on the capital investment. The difference in capital investment needs to be taken into account if two different investment opportunities are to be compared.

Total Cost of Ownership (Gartner 2009) TCO as Gartner TCO identifies costs as being made up of two major components - direct and indirect. Direct costs traditionally forms the area that organizations find easiest to measure and as a result direct costs can often receive undue or excessive focus. Typically, direct costs are made up of labour and capital costs. The other component in Gartner TCO is indirect costs. Indirect costs are more elusive and difficult to measure and rationalize. The 'soft' nature of indirect costs means that their impact on owning an IT infrastructure is often underestimated

Appendix B.5 - Learning and Growth view

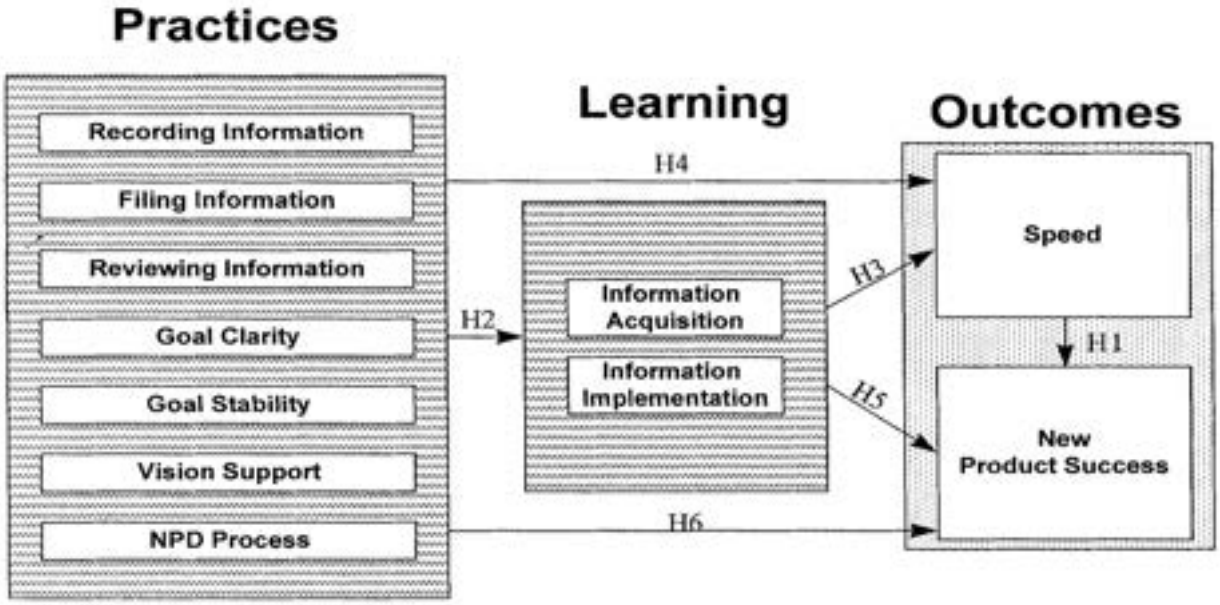

Figure 45 Team learning model

We have referenced (Lynn, Skov et al. 1999) and (Kirkpatrick 1994) as the basis for a questionnaire review together with **(Remenyi, Money et al. 2000)** for the ranking and scoring technique to convert qualitative into quantitative information. Figure 45 describes the (Lynn, Skov et al. 1999) learning model which has decomposed the team learning process into its generic components. Figure 46 describes the generic training evaluation model (Kirkpatrick 1994). How we have used these models and a justification for why we have restricted our measurement to the working environment are explained in detail in chapter 4.

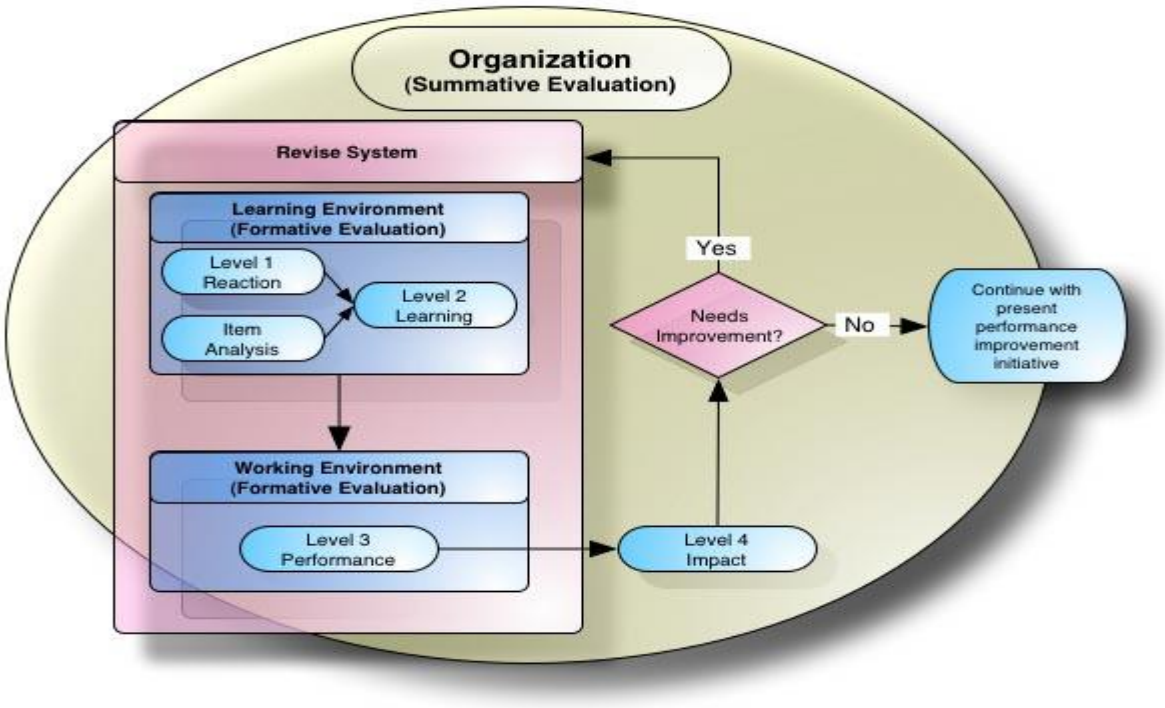

Figure 46 Kirkpatrick's training evaluation model

Appendix C Models rejected and why

In this appendix we describe potential candidates for a measurement model that have been analyzed and rejected because they do not the measurement model selection criteria as described in Table 2. In addition, models that could be potentially used have been rejected because they concentrate too much on a process-based approach without describing a framework for providing a helicopter view of an organization together with a mechanism for actually measuring and correlating the resulting tangible and intangible variables and supporting the reporting and analysis process.

(Zealand 2003) refers to real options theory as a management aid in deciding how to continue with an investment before a possible set of events have occurred. Real options theory seems to be also focussed on outcomes in a monetary context. Our context is measuring what there is as an aid to deciding what to do (or not to do). Our context is not about deciding how to invest. We are also interested in more aspects of investment and income than money. Real options theory does not therefore fit into our framework.

The performance prism has been rejected because (Purbey, Mukherjee et al. 2006) although it does suggest some areas in which measures of performance might be useful, it does not provide guidance on how the appropriate measures can be identified and introduced.

The 4 P's model from (Renkema 1998) describes the role and appraisal of investment in IT infrastructure but it does not describe how an IT investment can be mapped to business benefits. It does also not describe how to measure and compare both IT investment and the business benefits. Because these things are the focus of our research the 4 P's model has been rejected.

Porter's five forces (Porter 2008), as opposed to SWOT, is an outside looking strategic analysis of external competitive factors. Our objective is to measure what we have and therefore the five forces model is not in our scope. Nevertheless our measured results could be used as input for an analysis with this model.

4-phase EIAC (Exploration, Involvement, Analysis and Communication) from (Devaraj and Kohli 2002) has not used because even though it does describe a full process for defining tangible and intangible variables it does not explicitly distinguish between strategy, tactical and operational levels and it does not provide different views as provide by the BSC.

The SIESTA (Strategic Investment Evaluation and Selection Tool Amsterdam) model as referenced from the secondary source (Berghout and Renkema 2005) has not been used because it has been designed as an aid in the investment decision process. This is not in the scope of our measurement model.

Risk management is not in scope for our research because defining risks, associated with KPI's, is related to investment and a response to conclusions on the analysis of reported measurements. The BSC Tower should be used as an aid for analysis and risk management.

CMMI from (Institute 2009) is a process improvement approach that is an extension of the software process maturity levels put forward in (Humphrey 1990). CMMI offers a best practice

framework for improving processes but it does not mention specifically how to measure the relationship between business benefits and IT investment.

Cobit (Institute 2005) is a framework for aligning IT goals with business goals by providing metrics and maturity models for a measurement of achievement. One of its domains is Monitor and Evaluate IT Performance which covers the measurement of IT performance. Unfortunately Cobit only describes what to do but not how to do it, although it does mention the Balanced Scorecard as a means to measure performance.

VALIT (Institute 2006) is an extension of Cobit and is focussed on the investment decision (doing the right thing) and the realisation (achieving benefits) of benefits while Cobit focuses on the execution (the right way and doing things well). As with Cobit the Balanced Scorecard is mentioned without a description of how specifically to measure business benefits from IT investment.

EFQM (EFQM 2001) is an organizational framework which can be used for the following purposes: to assess organizations, benchmarking, strategy reviews and creation, basis for applying the European Quality Award. It is based around enablers, results and innovation and learning. Our reference (EFQM 2001) provides a description of a toolkit which provides a mixture of process description, checklist and scorecard. Two scorecards are described; (i) an organizational one to balance the performance results of the organization and (ii) a process scorecard to define the measurement category to be used. The organizational scorecard has four key areas that map directly to the Balanced Scorecard. Unfortunately EFQM seems to be a confusing mixture of process approach and borrowing freely from other models and ideas without providing a mechanism for measuring and correlating business benefits with the original IT investment.

Appendix D Measurement of application quality

Appendix D.1 Role and experience

1	In which department or section do you work?	
	Administrative	
	Medical	
	Other, please specify	
2	How many years' experience do you have working in your department?	
3	How many years' experience do you have working with computers?	
4	How many years' experience do you have working with patient logistics software?	
5	How many hours a week do you use the patient logistics software?	

Appendix D.2 Quality attributes

The following quality attributes are based on the quality attributes of an information system in use and have been referenced from (Pol and Teunissen 2002).

Attribute	Description
Availability	The level at which the non-automated (for example, human) processes are mapped to and supported by the information system.
Continuity	The certainty that information can be processed without disturbances. This is based on a number of factors: • The level at which disturbances occurs, for example, computer crashes. • The level at which information can continue to be processed even when a disturbance occurs. • The speed in which information processing can be restarted after a disturbance. • The level that part of the information processing can continue even when other parts of the system are not working. • The level at which part of the information processing can be continued from another location.
Controllability	The level at which the correctness of information and information processing can be checked and audited.
Economical	The level of efficient use of resources (CPU-cycles, I/O time, memory and network usage) related to the performance level of the information system (number of parallel transactions and related speed).
Functionality	The certainty that information is processed according to the functional specifications: • The level at which the system processes information into a consistent whole according to the specifications. • The certainty that all required information is processed by the system.
Performance	The speed at which the information system handles both interactive and batch transactions.
Security	The certainty that only those users allowed to access or change information are allowed to.
Usability	The level at which the information system is tailored to the organization and the end-users that are meant to use it.
User friendliness	The ability of the system to be easily learnt and used by new users and for the system to be easily re-used by experienced users.

Table 3 Quality attributes

Appendix D.3 Importance of quality attributes

Number	Attribute	Question	Irrelevant	Not important	Important	Critical
1	Availability	How important is the availability of EPIC to your work?				
2	Continuity	How important is to you that EPIC can continue processing and providing your information in spite of disturbances to the computer system?				
3	Controllability	How important is it for you that the information held within EPIC can be audited and validated for correctness?				
4	Economical	How important is it for you that computer resources required by EPIC are efficiently used so that information can still be processed even when there are a significant number of users working in parallel?				
5	Functionality	How important is it to you that all information required to be processed by EPIC is actually processed and processed into a consistent whole according to the functional specifications?				
6	Performance	How important is that EPIC handles both interactive and batch transactions at the necessary speed so as not to inhibit your activities?				
7	Security	How important is it that the information relevant to you is only accessed by people who should have access to this information?				
8	Usability	How important is that EPIC is tailored to your non-IT activities?				
9	User friendliness	How important it is easy for new users to quickly learn to use EPIC and for experienced users to easily re-use EPIC?				

Table 4 Importance questionnaire

Appendix D.4 Expected performance of quality attributes

Number	Attribute	Question	Very poor	Poor	Good	Excellent
1	Availability	What level of availability from EPIC to you expect?				
2	Continuity	What level of continuity do you expect from EPIC to continue processing and providing your information in spite of disturbances to the computer system?				
3	Controllability	What level of capability do you expect from EPIC in providing an audit trial of the information processed?				
4	Economical	What level of computer resource usage do you expect from EPIC so that information can still be efficiently processed independent of the number of users working in parallel?				
5	Functionality	What level of functionality do you expect from EPIC so that it can process all information successfully and provide all information processed into a consistent whole?				
6	Performance	What level of performance do you expect from EPIC in its processing of both interactive and batch transactions so as not to inhibit your activities?				
7	Security	What level of protection do you expect from EPIC against illegal or inadvertent access to information by people not having permission?				
8	Usability	What level of capability from EPIC do you expect in its support and interaction with you non-IT activities?				
9	User friendliness	What level of user friendliness do you expect from EPIC in its capability for allowing new users to quickly learn how to use EPIC and for experienced users to easily re-use EPIC?				

Table 5 Expected performance questionnaire

Appendix D.5 Actual performance of quality attributes

Number	Attribute	Question	Very poor	Poor	Good	Excellent
1	Availability	What level of availability from EPIC do you experience at this moment?				
2	Continuity	What level of continuity do you experience at this moment from EPIC when it needs to continue processing and provide your information and at the same time disturbances to the computer system have occurred?				
3	Controllability	What level of capability do you experience at this moment from EPIC in providing an audit trial of the information processed?				
4	Economical	What level of computer resource usage do you experience at this moment from EPIC during busy periods and when you information must be efficiently processed?				
5	Functionality	What level of functionality do you experience at this moment from EPIC when it needs to process all information successfully and to provide all information processed into a consistent whole?				
6	Performance	What level of performance do you experience at this moment from EPIC in its processing of both interactive and batch transactions so as not to inhibit your activities?				
7	Security	What level of protection do you experience at this moment from EPIC against illegal or inadvertent access to information by people not having permission?				
8	Usability	What level of capability from EPIC do you experience at this moment in its support and interaction with you non-IT activities?				
9	User friendliness	What level of user friendliness do you experience from EPIC at this moment in its capability for allowing new users to quickly learn how to use EPIC and for experienced users to easily re-use EPIC?				

Table 6 Actual performance questionnaire

Appendix D.6 Overall opinion of all quality attributes

Please rate your overall opinion of the information system:			
Very poor_____	Poor_____	Good_____	Excellent_____
Please supply any further comments you wish concerning the performance of the information system:			

Table 7 Overall opinion of the information system

Appendix D.7 Example of snake diagram graph

The data in the graphs in Figure 47 through to Figure 49 use the same data source which is not real-world data and should only be seen as a means to explain the combination and reporting of customer view data generated from the questionnaires. The analysis of each graph is therefore only based on what is shown and what is represented and these results may never appear in reality. It is important to indicate here that all data generated from the questionnaires is based on subjective opinions and that the data in the graphs represents averaged out values from a population that has answered the questionnaires.

The following example in Figure 47 shows that the perceived importance of the different quality attributes is greater than all attributes except for computer resource usage. A general lower expected performance than importance is an indicator that the organization expects less from an information system than it should provide. There are only two exceptions when we compare expected performance with actual performance. These are auditing capability and performance. The actual performance of auditing is identical to the expected. The expected performance is slightly less than the actual performance and when this difference is significant can be an indicator that there has been more investment in an attribute than is actually needed. All other attributes are performing less than expected which is an indication of dissatisfaction in the provided information system and also a system that may possibly need to be improved.

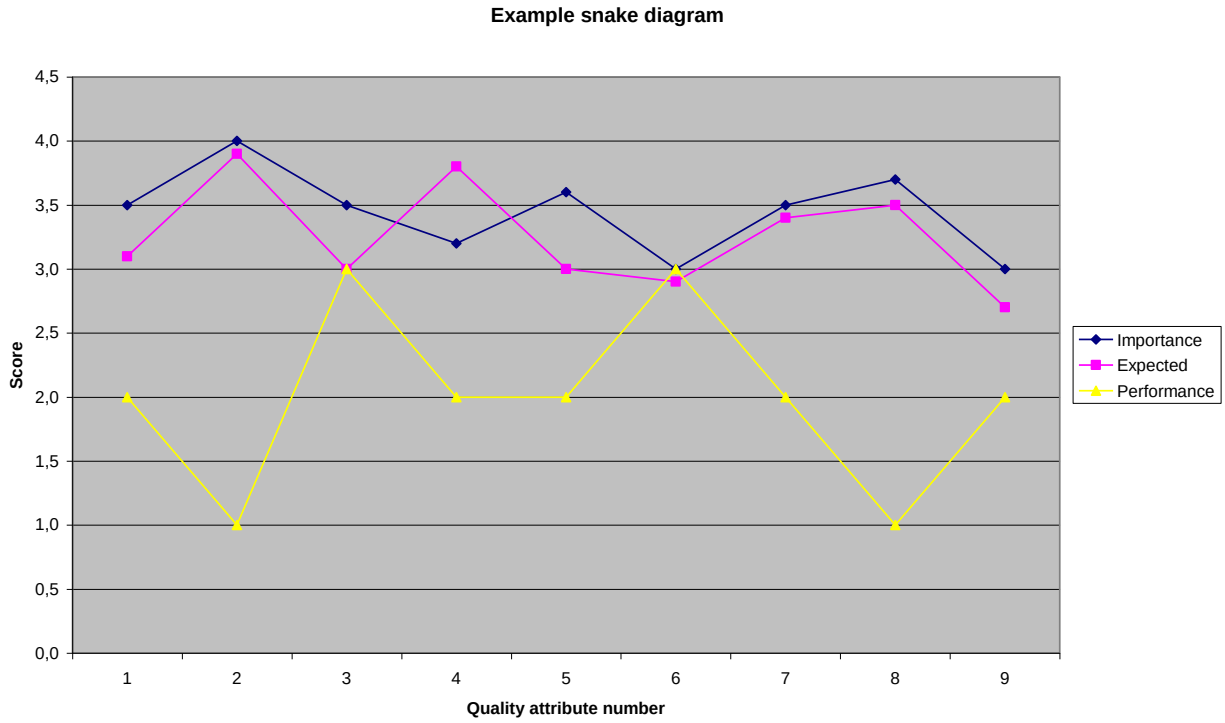

Figure 47 Example snake diagram

The following example in Figure 48 shows the expected and actual performance of the quality attributes together with the differences between these attributes. Any gap below zero shows performance less than expected, which is the case for the quality attributes availability, continuity, economical, functionality, security, and usability and user friendliness. This is an indicator of an organizational opinion that actual performance is lower than expected. The controllability (audit) and performance quality attributes have been addressed with the previous graph.

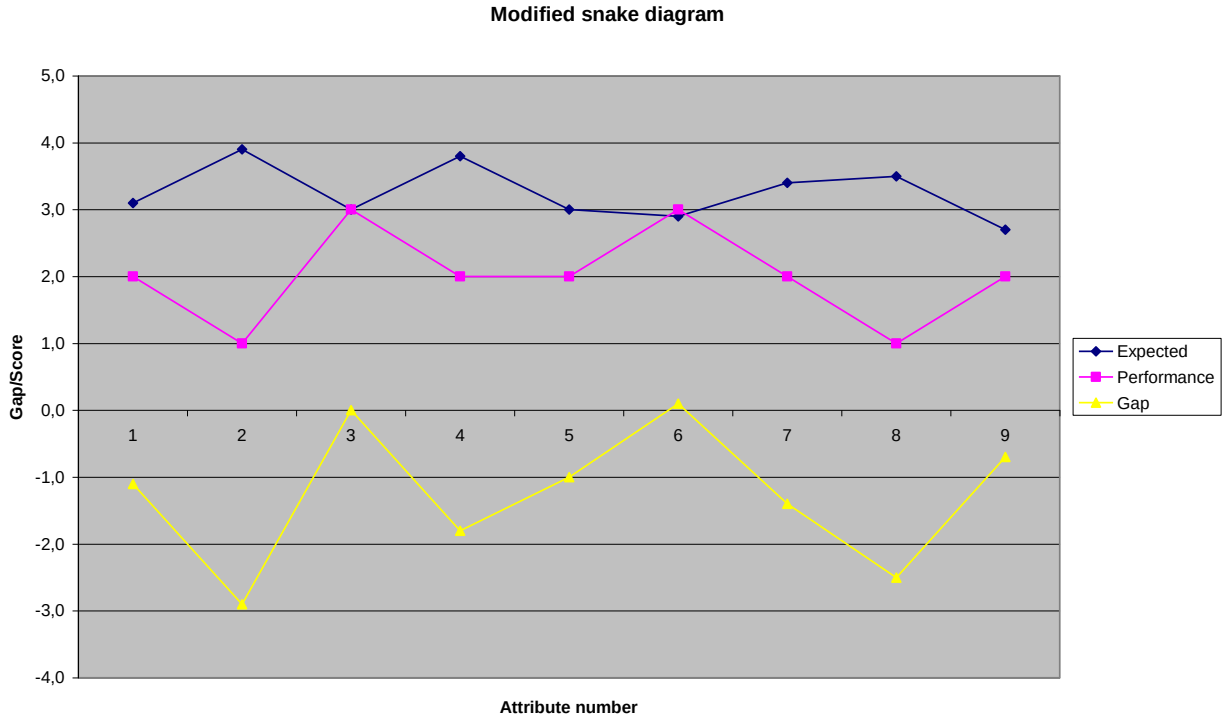

Figure 48 Modified snake diagram

The following example in Figure 49 shows the averaged out performance scores for all questionnaires against the actual performance and the organization's averaged out opinion of the information system in total. This could be an indication that, even though some attributes are scored badly, the opinion of the end-user organization is that the service organization was doing as well as could be expected.

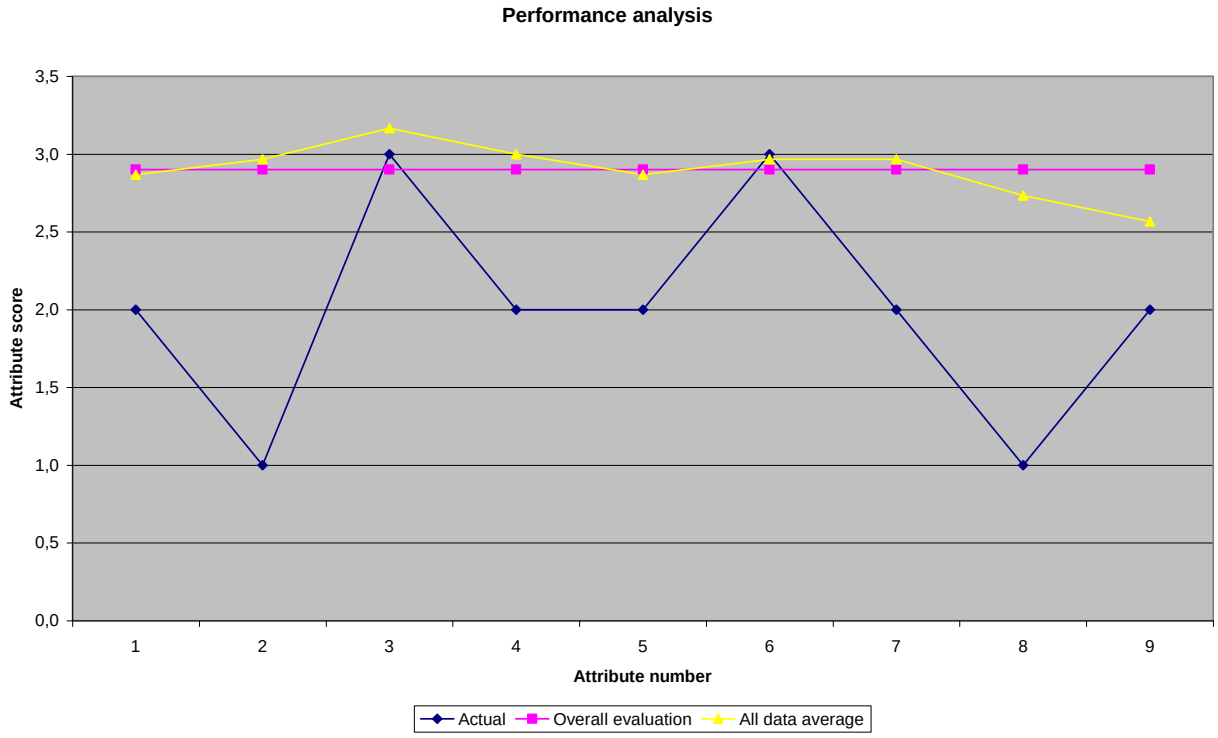

Figure 49 Performance analysis

Appendix E – Learning and Growth view data correlation

Appendix E.1 Role and experience

Use the same questionnaire as in Appendix D.1 Role and experience.

Appendix E.2 Working environment attributes

All of the attributes mentioned in Table 8 need to be addressed by training.

Attribute	Description
Objective(s)	This is the objective or objectives that is or are required to be achieved in the working environment either directly by the information system or enabled and supported by the information system.
Patient treatment	This is the ability provided by the information system to enable each user of the information system in the treatment chain of a patient to see the context and effect of their activities on the treatment chain.
Recording information	This is the optimal ability provided by the information system to support a user in the recording of information.
Filing information	This is the optimal ability provided by the information system to support a user in the filing of information.
Reviewing information	This is the optimal ability provided by the information system to support a user in the reviewing of information.

Table 8 Working environment attributes

Appendix E.3 Importance of training for working environment

Number	Attribute	Question	Irrelevant	Not important	Important	Critical
1	Objective(s)	How important is it, in your opinion, that the objective(s) in your working environment can be achieved or supported by optimal training in the information system?				
2	Patient treatment	How important is it, in your opinion, that training you in the use of the information system provides you with optimal insight into the effect of your activities on the treatment path of each patient?				
3	Recording information	How important is to you that training in the recording of information into the information system will optimize your ability to record information in the working environment?				
4	Filing information	How important is to you that training in the filing of information in the information system will optimize your ability to file information in the working environment?				
5	Reviewing information	How important is to you that training in the reviewing of information in the information system will optimize your ability to review information in the working environment?				

Table 9 Attributes to rate the importance of training

Appendix E.4 Expected use of training

Number	Attribute	Question	Very poor	Poor	Good	Excellent
1	Objective(s)	Do you expect that the training will help you to achieve your expected objective(s) in the working environment?				
2	Patient treatment	Do you expect that the training will help you to achieve optimal insight into the effect of your activities on the treatment path of each patient?				
3	Recording information	Do you expect that the training will help you to record information optimally in the working environment?				
4	Filing information	Do you expect that the training will help you to file information optimally in the working environment?				
5	Reviewing information	Do you expect that the training will help you to review information optimally in the working environment?				

Table 10 Expected use of training

Appendix E.5 Actual use of training

Number	Attribute	Question	Very poor	Poor	Good	Excellent
1	Objective(s)	Has the training helped you to achieve your expected objective(s) in the working environment?				
2	Patient treatment	Has the training helped you to achieve optimal insight into the effect of your activities on the treatment path of each patient?				
3	Recording information	Has the training helped you to record information optimally in the working environment?				
4	Filing information	Has the training helped you to file information optimally in the working environment?				
5	Reviewing information	Has the training helped you to review information optimally in the working environment?				

Table 11 Actual use of training

Appendix E.6 Overall use of training

Please rate your overall opinion of the training in its support of the working environment:			
Very poor_____	Poor_____	Good_____	Excellent_____
Please supply any further comments you wish concerning the performance of the information system:			

Table 12 Overall opinion of the training

Appendix E.7 Examples of training questionnaire results

The data in the graphs in Figure 50 through to Figure 52 use the same data source which is not real-world data and should only be seen as a means to explain the combination and reporting of the Learning and Growth view data generated from the questionnaires.

The following example in Figure 50 shows that the perceived importance of the different training attributes is greater objectives, recording information and reviewing information. A general lower expectation than importance is an indicator that the organization expects less from training than it should provide. The actual experience of the use of training for the attributes objectives, patient treatment, filing and reviewing information are all an indication that the training did not prepare the organization enough for using the solution in the working environment. An exception to this is the training of the recording of information which seems to fully, but no more, support this activity in the working environment.

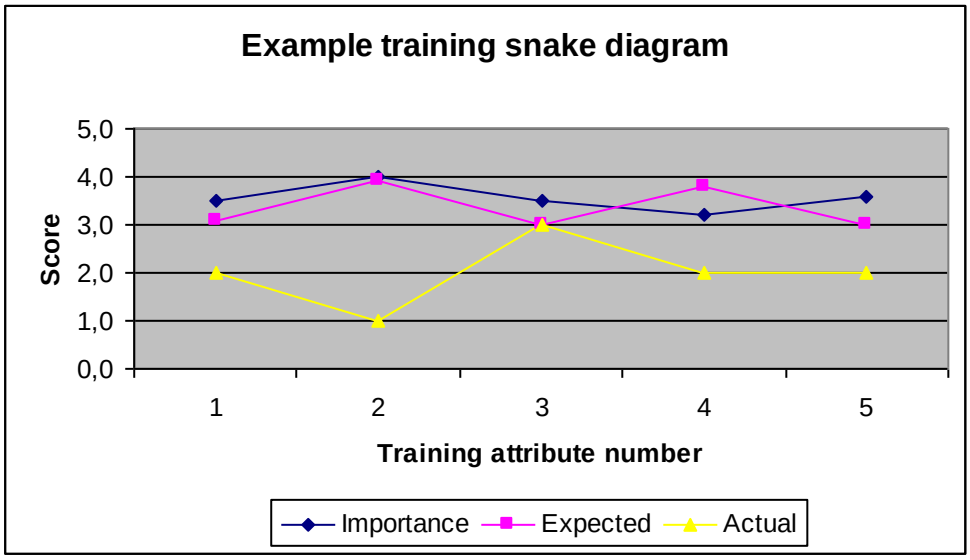

Figure 50 Example training snake diagram

Figure 51 highlights, as mentioned in the previous paragraph, that training has not helped the organization to achieve its objectives and using the solution in the working environment except for the recording of information.

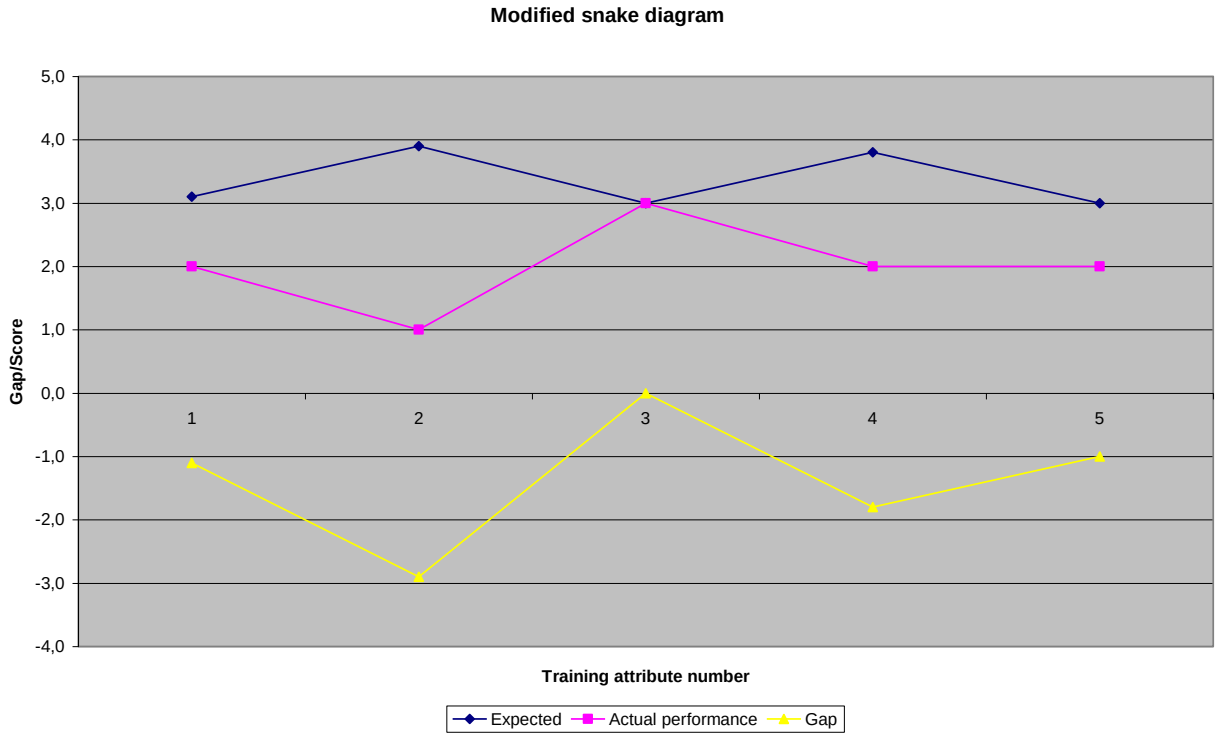

Figure 51 Modified training snake diagram

Figure 52 indicates that in the opinion of the organization the training has not satisfied the individual training parameters but overall the organization is satisfied with the use of training in the working environment. This might be an indication that the organization thinks that the training provided enough general knowledge for the organization to satisfactorily use the solution because there was enough domain knowledge within the organization and the organization understands and acknowledges that using a new system requires time in which to build the necessary basic experience and knowledge on how to use the system.

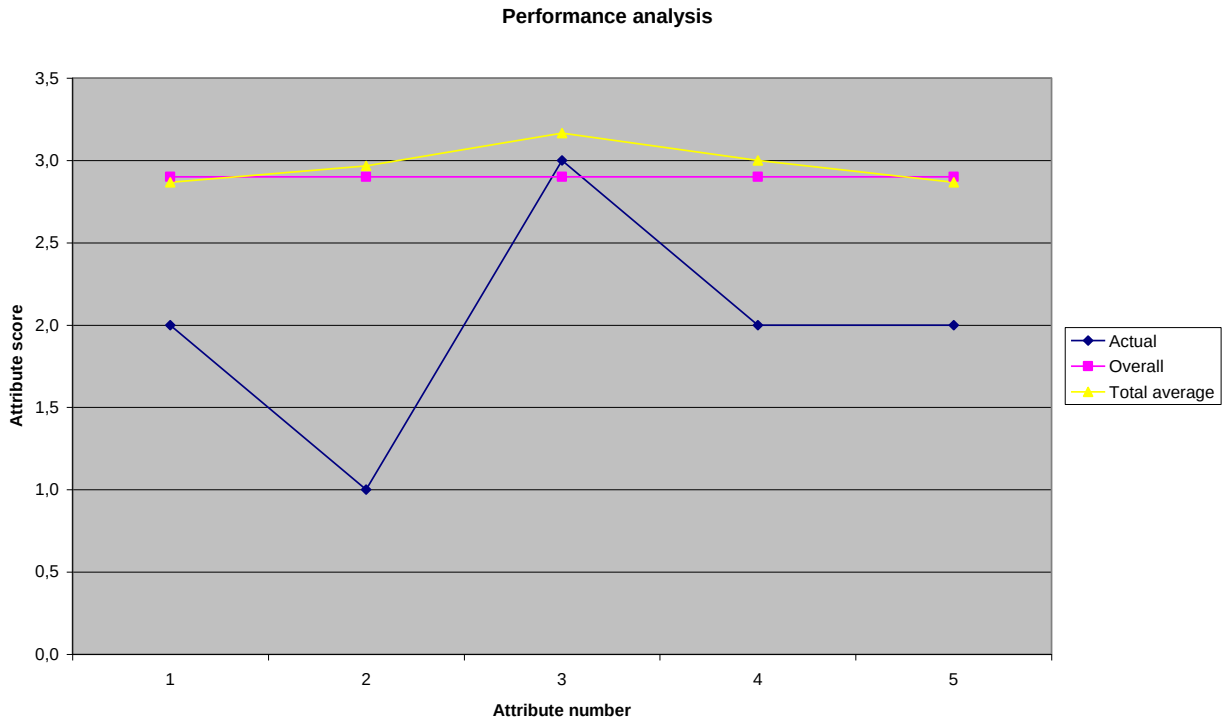

Figure 52 Training performance analysis

Appendix F – Tactical level – Internal processes

Appendix F.1 DBC Treatment

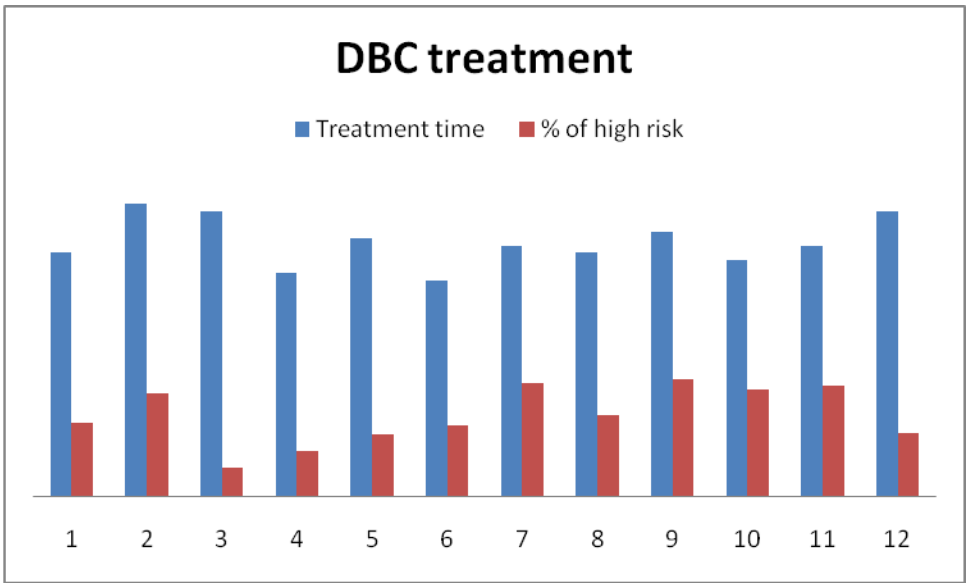

Figure 53 DBC Treatment

Appendix F.2 Quality of application

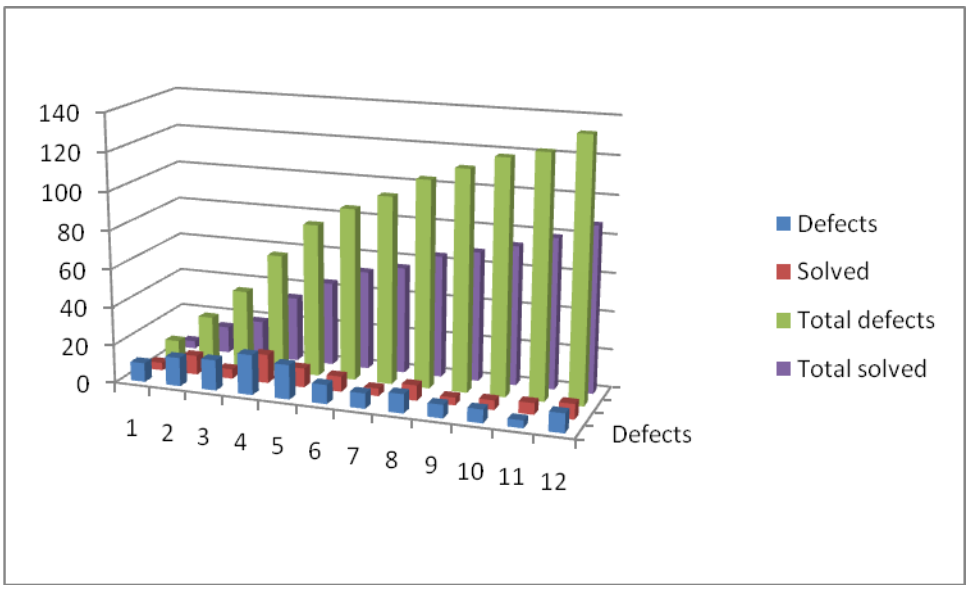

Figure 54 Quality of application

Appendix G – Operational level – Data gathered

We have used (Ward, Murray et al. 2004) as a basis for formal questions based on finding out about business benefits.

Appendix G.1 Interview results

Parts of the following interview content have been deleted because of their sensitive nature.

Appendix G.1.1 Spaarne Kickoff

Attendee	Role
Yvonne Wilders	Member Raad van Bestuur
Barry Jones	Student Master in IT Management (MITM)

Topic	Spaarne EPIC kickoff
Type	Determine if EPIC is a suitable topic for a thesis and if my sponsor thinks that I can provide added value for her. The objective is to get the go ahead from Yvonne so that I (Barry) can use EPIC as the subject of my thesis.
Date	15 October 2008
Time	15:30
Duration	1 hour
Actual duration	<= 1 hour
Location	Spaarne hospital

Summary of interview:

Barry described the background of the MITM, its modules and the context of the thesis.

Yvonne described the background of EPIC.

Text removed due to its sensitive nature.

A lot of money has been invested in EPIC but Yvonne would like to see the payback moment.

Text removed due to its sensitive nature.

Also the critical success factors need to be named both in terms of quality factors and money. The objective is to provide a systematic approach and make subjective CSF's productive.

Yvonne suggested interviewing the following stakeholders:

- *Text removed due to its sensitive nature.*

I need some start documentation (contract, costs..)

Appendix G.1.2 Research approval

Attendee	Role
Yvonne Wilders	Member Raad van Bestuur
Barry Jones	Student Master in IT Management (MITM)

Topic	Research Plan and approach for EPIC thesis.
Type	The objective is to get agreement from Yvonne on my Research Plan and my plan of approach.
Date	4 December 2008
Time	Spaarne hospital
Duration	1 hour
Actual duration	1 hour
Location	Spaarne hospital

Summary of interview:

Yvonne provided some feedback on Barry's Research Plan:

- Some of the things mentioned about Spaarne are not correct but at the moment this is not important because they can be corrected later.
- The solution space diagram is a bit unclear, especially with respect to expected and actual benefits.
- Strategic insight is extremely important.

Yvonne has approved the content of the Research Plan.

Yvonne mentioned Planetree (sycamore) and days later I have forgotten exactly what she meant by this. I think that it is something to do with decision trees but I am not sure.

According to Yvonne the challenge for today is to clarify what the expected benefits should be. *Text removed due to its sensitive nature.*

Some other relevant comments by Yvonne:

- What are the costs of alternative and similar products?
- Discounted Cash Value.
- *Text removed due to its sensitive nature*.
- Use Calculated Loss (how much quantitative) not payback moment.

Yvonne provided some documentation (TBD defined here) and her initial ideas on qualitative and quantitative benefits. She was also curious what the other stakeholders ideas were on benefits.

Appendix G.1.3 IT Kick-off

Attendee	Role
Removed	Manager ICT
Removed	Project Leader EPIC
Barry Jones	Student Master in IT Management (MITM)

Topic	EPIC payback moment – IT kick-off
Type	The first interview with the Spaarne head of ICT and the project leader responsible for the implementation of EPIC. (Free format interview)
Date	9 December 2008
Time	8:30
Duration	1.5 hours
Actual duration	1.5 hours
Location	GGD building next to Spaarne hospital

Summary of interview:

Barry had a presentation prepared but Andrea (especially) and Michel were mainly interested in telling their story about the implementation of EPIC and the culture within Spaarne hospital.

Michel, I think, mentioned the phrase of a "Project in a Project mentality" – I'm afraid I have forgotten what he meant by this. *Text removed due to its sensitive nature.* Michel mentioned that it is important to understand that people do not understand and that time is short. Michel mentioned that it is important with the introduction of any standard package that the end-user organisation should be led in the use of the package. It is important that the package is not continually changed as a results of demands from the end-user organisation because this will cause delays because of the additional time required to change the package which will result in less quality in the final product because of the over complexity introduced. He gave an example where a product had copies of similar functionality for different types of users resulting in significantly higher maintenance costs.

Michel was responsible for the implementation of phase 1 EPIC, which only introduced new functionality that had to work together with the existing functionality. He stated the advantage of this approach was that a ROI was achieved immediately after the introduction of this phase because new functionality was provided.

Andrea mentioned that a requirement on EPIC is that it must be fast. There are therefore people concerned that EPIC can conform to this requirement also without crashing. *Text removed due to*

its sensitive nature.

Another issue is the process responsibility over the whole process chain. *Text removed due to its sensitive nature.*

Michel mentioned that he comes from a logistics background and the problems to be solved by EPIC are logistics related. I mentioned Goldratt and the goal and Michel mentioned that he has provided 16 copies of "We all fall down" by Julie Wright and Russ Kring to representatives of the end-user organisation but no-one has read it yet because they are too busy.

Michel mentioned that changes generate money. He agreed with me that an optimal use of EPIC should provide time, money and quality benefits. He also mentioned that EPIC provides both planning and scheduling capabilities.

Michel mentioned that the predecessor to Yvonne (Wilders) has a business benefit requirement of seeing no-one waiting in a hospital queue. If this is an objective it should be, for example, possible to see one free bed instead of 16.

Money is required to change the organisation but how much is Spaarne prepared to invest? The mentality in the end-user organisation is that they do not want to change. People are scared of the truth or there is a fear of failure. Also doctors would prefer to go skiing rather than change their way of working.

Michel talked through an EPIC presentation that made it clear what the original selection criteria were.

Andrea supplied the original business case (paper) and here project plan (emailed, to give an idea of the functionality per phase and dates of Go Live). Barry will email Michel's kickoff presentation so that Andrea can check against here planning.

Andrea mentioned some other people who it might be interesting to interview:

- *Text removed due to its sensitive nature..*

Questions & Answers		
1	Why must you invest in the organisation?	Because everybody is too busy with their own "thing" and not with the full service chain.
2	Why does Spaarne have to invest in a new application like EPIC?	For two reasons: (i) The Business Model changes with DBC. (ii) The current application does not support care paths.
3	What is the business case for EPIC?	(i) The maintenance costs are similar to the costs for "t*ext removed due to its sensitive nature"* combined and EPIC provides more functionality. (ii) Investment (implementation costs) can be paid back by the following: • Organisation improvement (where

		do you want to be?, role of doctors changes, objective -> important people, training, changes.
4	What do you consider to be the business benefits to be gained from the introduction of EPIC?	Michel mentioned an example of a business benefit: out of the people that die in hospital the percent caused by medical fault should be brought back to *"text removed due to its sensitive nature"*. The problem is to convert this into some form of cost – what is the worth of a person? The cost of keeping *"text removed due to its sensitive nature"* "in the air" disappears.

Appendix G.1.4 Financial meeting

Attendee	Role
Removed	Bookkeeper
Removed	Manager Information, Economy and Administration
Barry Jones	Student Master in IT Management (MITM)

Topic	EPIC payback moment – Kickoff with Financial role stakeholders
Type	Q&A session to determine the costs and expected benefits associated with costs.
Date	11 December 2008
Time	9:00
Duration	2 hours
Actual duration	1.5 hours
Location	GGD building (next to Spaarne hospital)

Summary of interview:

Peter mentioned that Spaarne are more than satisfied with their relationship with EPIC and his contacts in healthcare have very different experiences (i.e. negative) in their relationships with other suppliers.

Text removed due to its sensitive nature.

EPIC should free time for the end-user organisation and this should help with patient satisfaction.

Additional comment from Peter:

Current rules-> estimate per year

Good, timely and reliable.

Quality gets better -> production gets higher.

Price/performance will be improved.

Performance per worker will be higher.

Sharon also mentioned that people in the end-user organisation are scared about losing their jobs. She mentioned that the opposite should happen because more will be expected from people because the resulting system is more sophisticated.

Peter mentioned that the rules (law) affecting hospitals typically changes about four times a year.

Hospitals continually have to adapt. He also mentioned that doctors (and the rest of the end-user organisation) need to change their way of working because the EPIC is an integral solution. People need to think in a service chain perspective for each patient instead of only concentrating on their part of the chain. He sees this as the biggest challenge for EPIC. If people carry on working in the same way then Spaarne could have invested in any kind of package.

Questions & Answers		
1	What are the expected implementation costs of EPIC and how are they split across the different disciplines and phases?	Refer to the summary for the years 2007 to 2009. The Business Case provided by Yvonne and Andrea provides this information in spreadsheet form. I should be able to understand this spreadsheet now because I understand the background context as described by Sharon and Peter. Peter mentioned that there have been initial costs because the American packet (EPIC) has rules that are different to those expected by Holland (this is always the case between different countries). EPIC provides: • Decision support. • Integral planning. • Care path logistic. • Resource management and planning. • More worth...
2	What are the operational costs for EPIC and how are they split across the different disciplines and releases?	Note in the summary of the interview that the fixed price EPIC contract has combined the implementation and operational costs into one. The answer to question 1 is therefore the same answer to this question.
3	What are the expected business benefits from a non-financial and financial view?	Sharon mentioned that EPIC should provide better planning and through better planning more patients can be treated with a follow on that Spaarne will earn more from treating more patients. Peter mentioned first that it should be feasible to get a 1% increase in turnover which translates to "*text removed due to its sensitive nature"*. Sharon mentioned that each hospital by law can decide how they want to invest 34% of the DBC money they receive without any intervention by the Dutch government. Sharon stated that "*text removed due to its sensitive nature"*. Peter mentioned the following five requirements on an integrated packet such as EPIC: 1. Optimal medical care path including

		medical decision support. 2. Patient only needs to come for an appointment when it is strictly necessary. This means that, for example, there diagnosis is ready. This will have a positive effect on the waiting list and therefore throughput. 3. Every medical specialist lead has to provide a medical summary report of the treatments in their specialism in the previous year. At the moment this is estimated to cost them an additional 100 hours work because the information that they need is not readily available. There therefore needs to be a Management Information System (MIS) that provides this medical information which is easily accessible. 4. The provision of timely, accurate financial data. This will allow invoices to be generated quicker than the current way. 5. The provision of strategic information from a MIS for company economic context and the provision of results based on scenarios. (It is intended that EPIC will be coupled with a datawarehouse to provide this business intelligence.)
4	What are the actual implementation costs for phase 1 and how do they compare against the expected?	Sharon and Peter both mentioned that the expected and actual costs for EPIC are (at least until now) identical because the contract is fixed price. The internal costs have been estimated.
5	What are the actual operational costs for phase 1 and how do they compare against the expected?	Implementation and operational costs are combined into one therefore refer to previous question for answer.
6	What are the actual business benefits for phase 1 and how have you measured them? (financial perspective)	Sharon and Peter (their comments combined) mentioned that in phase 1 there have been no real benefits because the full (integrated) potential of EPIC has not been realised because only some modules have been used. EPIC should be used as a fully integrated set

		of modules. The split of phase 1 and 2 has been in fact very expensive because workarounds in the combination of EPIC, "t*ext removed due to its sensitive nature"* had to be implemented. The result was a delay of "t*ext removed due to its sensitive nature"*. Peter mentioned that with a fully integrated EPIC it should be possible to save "t*ext removed due to its sensitive nature"*. Sharon did mention that a more efficient and timely invoicing will result in the fact that Spaarne will be able to borrow less money and therefore pay less rent. Peter mentioned a saving of approximately "t*ext removed due to its sensitive nature"*.
7	How do you expect to measure and provide evidence for future phases?	Sharon and Peter agreed that the figures that have been mentioned can be gathered.
8	Don't forget: • Business Case • Cost savings from DCC and Norma • FTE savings	These have been covered in the summary and the answers to my questions.

Appendix G.1.5 Healthcare domain and Spaarne experience

Attendee	Role
Removed	ICT PM
Barry Jones	Student Master in IT Management (MITM)

Topic	Spaarne EPIC
Type	Get more background information on what is expected from EPIC by asking Ed about his experience in a different hospital and comparing this experience to his experience and expectations in Spaarne.
Date	18 October 2008
Time	10:00
Duration	1 hour
Actual duration	1 hour
Location	Spaarne hospital

Summary of interview:

Barry described the objective and the context of his thesis:

Barry's objective is to provide a measurement framework that can be used systematically for providing evidence of the continuous improvement of the business benefits against the original and ongoing IT investment.

Ed described his background and what he has tried to do while working in another hospital:

Ed started his working life as a nurse. He worked in the OLVG hospital in Amsterdam first in coronary care and moved to the staff bureau as part of his role change and study of organisational science. Ed concentrated on the portfolio quality in the staff bureau. He was interested in the setting up of clinical care-paths and the underlying methodology which involves minimising waiting lists (and time), a quicker throughput for patient care, the working together of different departments while caring for a patient and the following on information exchange. He noticed that the patient dossier was not efficiently used when the patient was transferred between different departments. For example, a nurse created an existing patient dossier again for a patient being moved from heart treatment to a nursing department with a result that the patient information was unnecessarily duplicated.

Ed tried to simplify the approach to a more integral way of working. In his opinion 80% of all patient care within each specialism is identical for each patient. Using this knowledge it should be possible to simplify the definition and therefore work activities for each type of care. In the

opinion of the medical staff each patient is unique and the medical staff therefore use a significant number of different kinds of care type when in Ed's opinion it should be possible to group and therefore simplify the definition of these care types. Ed mentioned also the Boston Matrix and PDAC cycle to indicate the hospital domain is no different to any other business. See Ed's diagram for more insight.

Questions & Answers		
1	Why do we want improvement?	There is no insight in costs. The question "What do people do with their budget?" cannot be answered (70% of DBC's are fixed by the Dutch government and 30% are negotiable between hospitals and the insurance companies).
2	What improvement do we want/could we get?	A more efficient way of working and more insight into this way of working.
3	Where will it occur? 1. Can it be measured? 2. Can it be quantified? 3. Can a financial value be put on it?	Improvement on strategic, tactical and operational levels. 1. Yes, for example, evidence of average bed occupancy. 2. Higher capacity of treatment. 3. Look to the system. Manage on outputs (result oriented). It is possible to identify the relationships between healthcare paths and DBC's and this will help to change the organization.
4	Who is responsible for its delivery?	EPIC is responsible for providing an application that aids improvement. Improvement in the organization will require a mindset change in the organization. At the moment no-one is responsible for this.
5	What changes are needed?	Integral approach. From department context mentality to healthcare chain process mentality in the organization.
6	Who will be affected?	Satisfaction of the hospital organization and patients will be increased.
7	How and when can changes be made?	Sell the benefits to the hospital organization. A Pareto 80-20 approach should be used to improve healthcare treatment paths. Measure per healthcare speciality.

Appendix G.1.6 Operating theatre experience

Attendee	Role
Removed	Implementation EPIC
Barry Jones	Student

Topic	EPIC payback moment – operating theatre experience.
Type	Structured interview to determine expectations on EPIC based on domain experience.
Date	22-12-2008
Time	10:00
Duration	2 hours
Actual duration	1 hour 50 minutes
Location	Spaarne (Building G, fourth floor)

Summary of interview:

Theo's background is as operating theatre lead. He began as a nurse. An operating theatre lead co-ordinates all the activities required to efficiently and smoothly use the operating theatre. He originally worked as an operating theatre lead in Haarlem and was also responsible in this role for Haarlem and Heemstede together. Unfortunately the then existing systems and the way of working did not make it possible for a centrally coordinated and seamless management between Haarlem and Heemstede. Information on operating theatre usage was held in a mixture of word, excel (both used in a non-standard way) and knowledge held between people's ears. This did not work always efficiently. The result was that operating theatres were used inefficiently and the required insight into planned and historic usage was missing. Requests for operating theatre time were issued with a paper request. Requests for laboratory results were sent into a "black-hole" with no indication (or trace) of when the results would be available or the status of a request. Operating theatre nurses were responsible for the sterilisation of equipment and the cleaning of the operating theatre.

There are currently 8 operating theatres in Hoofddorp and three in Heemstede – Hoofddorp also has an additional theatre specifically for non-critical small operations for children and another for heart treatment, specifically pacemakers.

The objective of EPIC is to support the optimal use of the operating theatres and the associated resources (for example, people, disposable and non-disposable equipment). Heemstede is now totally managed centrally from Hoofddorp.

EPIC provides the ability to plan and provide historic insight into operating theatre usage because it provides an integrated work-flow which provides real-time status of where you are in any patient treatment chain. This is achieved through the use of preference cards which have hooked underneath them the procedures required to complete the treatment. Doctor's assistants request operating theatre time through EPIC. The type of operation and the related procedures allow other roles in the treatment chain to prepare more efficiently and more accurately. An example is that the people responsible for sterilising equipment now can sterilise the necessary equipment and make it available, the day before, in the operating theatre as part of their planning and preparation. A result is better resource management of equipment. The responsibilities for roles are now more clearly defined, nurses nurse, cleaners clean, sterilisation staff sterilize equipment. The access to a patient's treatment chain is context and therefore "need to know" sensitive. It is possible to therefore save on costs. There are a significant number of different reports available and all are accessible through role-based access. The doctor's assistant plans the operation for a surgeon. The anaesthetist is responsible for a log book of activities during an operation. At the moment not all information that could be fed into EPIC is but it is hoped that this will be more the case in Phase 2. If the information entry and storage capability of EPIC is utilised then the following benefits could be achieved:

- Performance.
- Education – by providing evidence of attendance at operations.
- Correlating patient complaints with what has been done.

The result is that it would be possible to request for more money from the government because evidence can be provided to justify any claims.

Nevertheless, there is a resistance to the use of EPIC within the user organisation because they think it will cause extra work. An example; a doctor sees four patients in a week and then afterwards does the administrative work to report on the work he has done. With EPIC he will have to enter information while he is seeing the patients and the doctors consider this extra time and a waste of effort. On the contrary entering the information in real-time will mean that the doctor's administrative tasks will shrink because the necessary information is already available in the system. Another advantage is that the material and apparatus management will help to stop mistakes such as the misuse of instruments and the associated usage can be reported on.

In summary the work processes will be more efficient and a track and trace capability will be available because the record of all activities will be centrally managed.

Theo mentioned that there are three levels of reporting:

- Forecast needs for operational purposes.
- Historical.
- Trend analysis.

He also mentioned that stock management was not going to be provided by EPIC and this is in his opinion a missed chance for logistics management.

Management reporting is possible and Spaarne use Clarity and Crystal Reports for more detailed reports. Enterprise reporting is possible but there is not enough information fed into the system at the moment to support this. Documenting the necessary information in the system is an extremely important activity that the organisation should be involved in.

Spaarne plans 3 months into the future. It would be possible to demonstrate exactly what DBC's actually cost in detail.

The change management of the organisation is missing and it is important that the organisation changes to work with the way that EPIC works.

Doctors lose a lot of time with administration activities.

Spaarne estimated that they need about 8,5 operating theatres to satisfy their needs. EPIC has significantly helped because planning and scheduling of operations are possible with a result that more patients are operated on and all the necessary information is stored within EPIC.

Surgeons have a daily 7.5 hour roster time in which they can perform operations. The planning and scheduling capability of EPIC has meant that daily operating times are more efficiently used with a result that fewer operations occur after the normal end time of 16:00 which is also supported by a more efficient logistics management.

The following things are important:

- A change in the organisation.
- Less spending on the organisation and material
- The role of people will change.
- Information is (taking role based access into account) centrally available with a result that there should be less patient complaints because there should be less mistakes. There should be a reduction in infections due to complications (which cost per patient €30k).
- Through the use of preference cards there are no or less unnecessary activities carried out and therefore more excellence should be achieved.
- More efficient use of operating theatre time has resulted in less overtime and therefore a reduction in costs.

Some things that need to be taken into account:

- The capabilities of the application and the requirements of the organization were not totally taken into account before signing the contract.
- The owner (i.e. the person in charge) for organizational change has not been explicitly named. Changing the organization as it should be is a risk.
- The interaction with organizations outside Spaarne is vulnerable. There is a test currently planned that is significantly behind in time. The interface between EPIC and the external systems of these organizations and the interaction between these external organizations and Spaarne is not fully worked out and because they are part of the patient treatment chain these external organizations form a risk to Spaarne. The following points are important:
    - Maintenance.
    - Mutual dependencies.
    - Cooperation in treatment chain process.
    - Maintenance requires continuous check on synchronous cooperation between Spaarne and the external organizations.
    - Integral cooperation:
        - Maintenance in. _ resource management

        - Maintenance out. /
- Challenges: electronic resource ordering from the external organizations:
    - Chemist
    - Clinical and medical laboratory
    - Medical biological laboratory
- Upgrades from system and the necessary testing.

Appendix G.1.7 Supplier

Attendee	Role
Removed	Project Manager EPIC
Barry Jones	Student

Topic	EPIC payback moment – interview with supplier
Type	Structured interview to determine how EPIC can support expected business benefits.
Date	22-12-2008
Time	13:00
Duration	1 hour
Actual duration	1 hour 45 minutes
Location	Spaarne (Building G, fourth floor)

Summary of interview:

"T*ext removed due to its sensitive nature"*

Debbie is BDM (Business Development Manager) for EPIC in Europe. She started as a nurse and has many (> 20) years experience in the medical profession. She is in addition the project manager for the implementation of EPIC in Spaarne. This involves focus on the business process, change management, end user adoption, project product design and helping Spaarne set up the configuration.

Questions & Answers		
1	What is your role and background with respect to EPIC?	BDM for EPIC Europe and PM for EPIC implementation in Spaarne.
2	What in your opinion are the business benefits from EPIC?	Debbie mentioned a document produced by Andrea and Yvonne which describes the business drivers. I think I have a copy already but to be sure she was going to email me a copy.
3	What are the risks?	Change management initiatives -> what needs to happen?
4	Why do we want improvement?	Efficient use of resources and insight into this is not available in the existing systems. Measurement was not possible. The current systems "t*ext removed due to its sensitive nature"* automated the then existing work processes (successfully) but because it is not possible to provide evidence on how people improve it is not possible to go to the next level.
5	What improvement do we want/could we get?	We want to replace what they already have (Phase 2) and then add additional things (Phase 3) so that timeliness and efficiency are improved. Debbie has done a (functionality) fit in "t*ext removed due to its sensitive nature"* -> speciality focus key provide information at the right time. Change the mindset of the physicians. Insurance evidence DBC efficient which will result in less costs for society. Not all patients can be treated so a decision on the right patients to use resources on has to b e made. Holland has to move to a customer service approach. The patient portal is an example of this which should increase the image of Spaarne.
6	Where will it occur? • Can it be measured? • Can it be quantified? • Can a financial value be put on it?	It covers almost the entire organisation but EPIC will not cover inventory and supply management, HR, Grote Boek, but it will cover all patient centric processes and will interface if needed. • Qualitative and Quantitative improvements: ○ Reduction in physician time (but only if they are doing something

		else!). ○ Budget based on fixed amount of patients which is tied in with Dutch law. ○ A reduction in staff costs because there are less people standing by. ○ Record is there when they want it. ○ All data to make a decision is available when they open the patient's record. ○ Duplicate tests are not needed (which are asked for when the results are not available and it is not known when they will be). ○ Physician satisfaction. ○ Customer satisfaction (which is the focus in U.S.). ○ Better outcomes from care for insurance companies and patients. First objective is to maintain what you have and then grow and increase budget. ○ Workflow outside of application with patients is important. IT is only an enabler. • The information is available in EPIC. • The DBC information is available in EPIC.
7	Who is responsible for its delivery?	Bedrijfsleiders, medischeleiders (for every group) and doctors (who initiate and drive workflow) are responsible for the delivery from the organisation. End responsibility for the organisation lies with Yvonne Wilders. The Spaarne organisation is quite flat in the sense that there are not many hierarchies. Yvonne is responsible for the delivery of EPIC.
8	What changes are needed?	Change management of the organisation. Doctors do not have financial responsibility for the resources used the hospital is responsible.
9	Who will be affected?	Sometimes the improvement is not for doctor. • Asking what extra medicine is required downstream. • Integrated planning -> doctor's can plan

		their time better but not cancelling patient's restrictions of doctor scheduling. Less phone-calls because centrally held patient information is more accurate. More time save on the backend.
10	How and when can changes be made?	Some changes are part of training. Some things are not currently planned in because Spaarne is not ready, for example, an improvement outside product is the ability to make joint appointments.

Appendix G.2 Spaarne documentation summarised

Spaarne hospital have provided a business case, some financial data and a presentation. The business case contains a justification for the purchase of a new application. Insight into the costs of the contractual period is provided with the financial data. An explanation of the functional requirements is provided in the presentation. The Spaarne documentation has been reviewed as part of the literature review process.