Strategic insight in the Capacity & Efficiency with Hospital data

"How can collected hospital data be used to give the board of directors strategic insight in the efficiency of the operational business capacity and volume of the academic hospital Radboudumc?"

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Preface

This document is the final project of my study Business Administration Information Management. The Master thesis is the final product to conduct the Master Degree of Business Administration. In collaboration with the Radboudumc and University of Twente this research was conducted.

This research had therefore two mentors from the University of Twente and one mentor and one business case owner from the Radboudumc.

The academic guideline and support I got from Ton Spil, was just was I needed to keep the balance between the academic aspect and the business case. I am also thankful for the feedback Henk Kroon provided me to complete the thesis.

I am thankful for the support and possibilities handed to me by my the department PVI and the Radboudumc. Also I want to acknowledge my supervisor Bart van Acker, which helped me to understand the complexity and challenging data environment of an hospital. My practically second supervisor who started as the business case owner of the project Marnix Nillissen, was able to help me understand the strategic needs of an hospital.

Last but not least I would like to thank Stefan Jansen, who supported me in the final phase of finishing this document.

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Abstract

This research focuses on the strategic insight of operational business capacity and volume of the patient care process. The reason for this research was to generate new insights on how to monitor, report and measure the operational business capacity and volume of a hospital. The approach is problem oriented and conducted at the Radboudumc in the Netherlands.

The design science research methodology from Pfeffers, Tuunanen, Rothenberger, and Chatterjee (2007)was used. This is an approach which focuses on the development of information systems. The objective of the solution is to gather information from the hospital systems to give insight in the operational business capacity. In the literature there was no solution found which deals with the same problem. Therefore literature study about strategy, management information systems, Balanced Scorecard, business capacity were conducted to create a theoretical concept. This results in an ideal BSC for the healthcare and indicators for the perspective; internal process.

In the design and development phase the design construct was created, which represents the development from the organisation strategy to the internal process perspective. Based on the design construct the testable construct is developed which includes the measures. The indicators within the testable construct are based on the literature. Therefore interviews have been hold to gather information. The testable construct emphasises the outcome and performance drivers according to Kaplan and Norton (1996). For the demonstration of the testable construct a prototype in Tableau was developed, which visually presents the indicator with hospital data.

The validation was conducted in two phases. The first phase was to transform the desired abstract; the testable construct, to the actual abstract; the prototype. In this phase the availability of the data was checked and the current reports were considered. The second phase was the iteration process which was used to develop the prototype. There were eleven interviews hold with ten internal experts and one external on the topic of operational business capacity and volume.

During the first phase the availability of the data was a concern. There is only one performance driver available of a total of nine. The performance drivers are crucial to the construct. They report the measures and give the critical insight to determine the efficiency of the patientcare process. In the second phase the interviewees agreed that the current report holds insufficient information about the operational business capacity and volume. The experts confirmed that the testable construct identified the information which is needed to monitor the operational business capacity and volume. The performance drivers are identified by the experts as relevant. The prototype cannot provide strategic insight, due to the lack of data about performance drivers and that the strategic goals cannot (current formulation) not be direct related to the operational business capacity and volume. Yet the prototype was seen as an improvement, which gave them more information and new insights.

The contribution of this research is the model on how to develop an information system (Tableau) for hospitals about the strategic insight in operational business capacity and volume. This model is applied to the Radboudumc and the measurements are validated by experts. The BSC model can be used to develop information and indicators for the other perspectives. This will need further studies to gather information. The current prototype can be used to develop targets and generate strategic goals. If the information about the realised capacity and the available capacity can be gathered, the historical data can be used to forecast the information.

Glossary and definition of used words (and Dutch translation)

Table 1 – Glossary and definition of used words

English word	Dutch translation	Definition
BI	BI	Business Intelligence
Board of directors	Raad van Bestuur	The Management of the Academic Hospital
BSC	BSC	Balance Scorecard
Business capacity	Werkdrukte/ gebruikte middelen	The volume of available resources. Like hospital beds, operation room usage.
Clinic	Kliniek	If the patient is hospitalized
Day Treatment	Dagopname	If a patient does not stay the night
DSRM	DSRM	Design Science Research Method
HC	Zorg	Health care
HIMSS	HIMSS	Healthcare Information and Management Systems Society
Hospital Data	Ziekenhuis data vanuit Epic	Data which is generate and collected within the hospital (no external values)
KPI	Kritieke prestatie-indicator	key performance indicator
MIS	MIS	Management information system
operational business capacity and volume	Bedrijfsdrukte	The volume of the hospital of business activities which are available and used
OR	OK	Operationroom
Outpatient Clinic	Polikliniek	The part of the clinic where patient visit for a appointment
S.T.R.O.B.E.	strategische oriëntatie van ondernemingen	strategic orientation of business enterprises
The efficiency of the operational business capacity and volume	Doelmatig	Efficiency of the resources of the hospital.

1. Problem Identification and Motivation: Introduction

This research is conducted in a collaboration with the Radboudumc to explore the need for strategic insight in the hospital data. This is done with an Design Science Research Method (Pfeffers et al. 2007). The first chapter defines the specific research problem and justifies the value of the solution according to Pfeffers et al. (2007)

The DSRM steps are defined:

- Problem Identification and Motivation: lack of concept to developed information system to monitor efficiency of the operational business capacity and volume
- Objective of the Solution: Literature study about Strategy, management information systems, balanced scorecard
- Design & Development: Objectify the literature for the case of the Radboudumc
- Demonstration: Incorporate the indicators in a Dashboard for monitoring
- Validation: Verifying the indicators and the need of the Dashboard
- Communication: Documentation of the conducted research (this document)

The research provides a guideline to fill in the internal process perspectives for the BSC for a hospital. This is described in the design and development process. It also demonstrates possibilities for presentation of the measures, a tool option and interaction and levels for a Dashboard.

1.1. Research question and research objective

The aim of this research is to design a construct to support the strategic level of an hospital to gather strategic insight in the efficiency of the operational business capacity and volume .

The capacity and volume needs to be defined and also what the efficiency of the operational business capacity and volume is. Also the strategy objective on the topic business capacity has to be identified to design a construct. This will be conducted with literature study and a design science approach at a academic hospital.

1.1.1. Research question:

"How can collected hospital data be used to give the board of directors strategic insight in the efficiency of the operational business capacity and volume of the academic hospital Radboudumc?"

1.1.2. Sub question:

1. What is the operational business capacity and volume?
2. What is strategic insight and how to identify it?
3. What strategic insights are needed and useful for the board of directors?
4. How to identify the strategy which is related to the efficiency of business capacity?
5. How to measure the efficiency of operational business capacity and volume?
6. Can collected hospital data give enough insight in the efficiency of the business capacity?

The hypotheses is that the data of the business capacity is correct registered and the hospital data is stored. Then the data can be transformed to information so that there is strategic insight in the efficiency of operational business capacity and volume. The transformation will be analysed with a construct from the literature and the real situation of the Radboudumc. It is recognized that the storage

and registration have impact of the quality of hospital data, but for this research it is assume that this happens correctly.

1.1.3. Research objective

This research aims to understand the development of indicators, how to identify relevant values to give strategic insight in the operational business capacity and volume. This will be qualitative assessed. The identified information will be used to build a management information system in a form of a dashboard.

1.2. Research design

To answer the research question a Design Science Research Method is chosen. (Pfeffers et al. 2007)

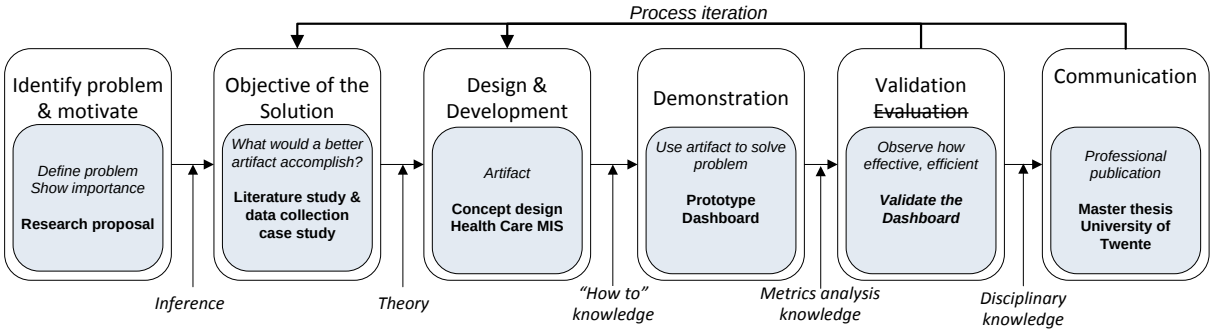


Figure 1 – DSRM based on Pfeffers et al. (2007)

The figure 1 DSRM Process Model is based on the model from Pfeffers et al.(2007) this model has one alterations. According to Wieringa (2010) the DSRM empirical research can be used to validate or evaluate the artefact. In the validation step the artefact will be verified with the user and the evaluation controls after implementation if the user is satisfied. Due to time limitations this research will validate the artefact in the finale stage instead of the evaluation process.

Problem Identification and Motivation	The motivation to conduct this research is, that there is not yet a concept developed of how a board of directors can have a strategically insight in the efficiency of the operational business capacity and volume. There is research about how to design MIS and how to monitor the process, but those use a bottom up approach or only focused on separate departments. This research aims to design a construct for the overall insight of efficiency of business capacity of an academic hospital. Also it will contribute on how to construct measurements to monitor business capacity. The measurements will be designed in a real life setting of a case study.
Objective of the Solution	The objective for this research is to develop a construct that will help to build a management information systems. This construct will help to determine the indicators which should monitored to understand the efficiency of the operational

	business capacity and volume.
Design & Development	The construct will be designed with existing theories about management information, strategic alignment and balance score card. This will be combined with theories about health care improvement and lean implementations within the health care sector. The construct will be developed to a testable construct and also a prototype of a MIS will be built.
Demonstration & Validation	In this research demonstration and evaluation is combined and further referred to as the validation step. In that step the construct will be tested and validated with a prototype with real hospital data. This prototype is the real world test of the construct.
Communication	This research, the construct and the validation will be part of this master thesis report. The hospital own data will not be used, therefore mock-up data will be generated to present the prototype in the thesis.

Limitations of this research design are the external validity. The validation happens within only one academic hospital within the Netherlands. Therefore the artefact can be valid in this environment but could be not applicable in another academic hospital in the Netherlands.

1.3. Literature Selection Method

To find the right literature the approach of Wolfswinkel, Furtmueller, and Wilderom (2013)is used. The steps in his method are define, search, select, analyse and present.

The first step is define the criteria for inclusion or exclusion. The research problem concerns different topics. Therefore different articles and theories concerning those topics are gathered. Those three main topics are, Management information system in Hospitals, Strategic alignment, Balanced Scorecard in Healthcare, Business capacity in Healthcare. The distinct and extended elaboration can be found in the Appendix A.

1.4. Case selection

In this section the case selection is defined. The Radboudumc in Nijmegen, is an academic hospital. The departments are independent from each other but there are interrelated by the same information systems and their work in an network structure together. Every department is obligated to report about their business activities to the Board of directors.

It has implemented the information system to stage 7 according to the HIMSS Stage 7 Award. The EMR Adoption Model is the guideline for the HIMSS Stage awards. The stage 7 describes how well the hospital has implemented their electronic medical record. The level 7 describes according to the website of HIMSS (2014): “Complete EMR integrates all clinical areas (e.g. ICU, ED, Outpatient,

displacing all (medical) paper records in the hospital, Continuity of Care standards to exchange data; Data Warehouse used as basis for clinical and business analytics."

The current identified situation is that the board of directions of the Radboudumc would like to have better understanding about the efficiency of business capacity. At this moment there is a reporting procedure to provide them with the needed data, but this is limited. Thus this issue identified within the literature and in a real world setting.

Radboudumc is due to their enhanced usage of EMR an interesting case. They have stored two years of hospital data from their EMR and can access the data with Business Intelligence tools (for example) SAP Business Objects. The implementing of lean thinking and the explicit need for more information creates an accessible research environment.

1.4.1. Case Selection for Validation

There was a design construct and a testable construct built to develop a prototype. Those construct were built from the literature and archival records of the Radboudumc. To validate the prototype there were ten people interviewed, which are experts on the topic within Radboudumc. There is one person interviewed which is at that point extern but is a former employee of the Radboudumc. The people which are selected and why there are selected is described below.

A member of the board of the directors, who is involved with the monitoring of the business capacity strategy of the operational Excellence. He is also the main stakeholder of this research topic. Then a manager of the Service department Process Improvement and Innovation(PVI), who has projects and experiences on the topic operational excellence. Also two consultant of the service department PVI, which generate reports for departments about specific questions about the efficiency of the operational excellence. Another manager from the service department Business Intelligence and Analytics(BIA), this department develops the report, data models to communicate hospital information. There is also an information analyst interviewed of the department BIA, because she is involved in building the data models for the monthly report of operational excellence. The business manager of the Urology department is interviewed, because she is focused on the operational excellence in her department. Business analyst of the Anaesthesiology is interviewed because of her knowledge about the operation room. The manager of the financial - strategy and control department (Concernstaf - Finance) is interviewed, because she has a strategic view on the Radboudumc. Also a Senior advisor of the same department are interviewed. They Senior advisor supervises the project to build a monthly report to inform the board of directors about the operational excellence. The last person is the external advisor who worked for the department strategy and control - finance.

The selected people are experts within Radboudumc on the topic operational excellence and how to gain insight in the data. The internal validation it strong because of those diverse experts. But this validation step is weakens the external validation. It was chosen to only validate with internal experts because of the privacy of the data. Also a validation with dummy data would not have the effect on recognition of the data.

1.5. Data collection method, operationalisation and data analysis

The chosen research method is the design science research methodology. To gather information the approach of data collection is similar to a case study. According to Yin (2013) case study use in-depth inquiry to give insight into a specific and complex phenomenon (a case). The inquiry is conduct in a real-world context. The data will be collected through interviews with the people involved and

concerned about the reporting function for the board of directors. This will be the departments: Process Improvement and Innovation(PVI), Business Intelligence & Analytics(BIA) and also the department which advises the board of directors and the board of directors.

Also normal business activities of the medical departments will be observed and existing documentation about procedures within the Radboudumc will be studied. One argument from Robert K. Yin (2013) to improve the validation of case studies is to use triangulation. Within this research the methodological triangulation will be used. R. K. Yin (1981)explained that evidence used in case studies can come from different methods like, fieldwork, archival records, verbal reports, observations, or any combination of these.

The main three used methods will be: Analysing archival records and reports within the case (Radboudumc). Observations of the involved employees and the stakeholders. Interviews involved employees and the stakeholders

1.5.1. Archival records

The Radboudumc, like other organisations documents about their strategy's, their vision and mission. These document go further into detail about how to implement those vision and strategies. The documented information will be analysed and used for recent and historically information collection. Mason, McKenney, and Copeland (1997) stated is that history reminds humans of the broad degree of complexity, intricacy and unpredictability that surrounds any real circumstance. History events and documented information cannot be observed anymore, but can give useful insights in the case.

1.5.2. Observation:

The observation will be reported with field notes and will be collected by accompany an internal advisor. This will be individual meeting with department members or group meetings. Those will be reported directly and some of them will occur only once and other will occur monthly. Baker (2006) defined observation as a systematic recording of observable phenomena or behaviour in natural setting. The filled role of the research in this case will be the moderate/ peripheral membership(Baker (2006). This means keeping the level of involvement in balance met the outsider role. The outsider role is needed to have an objective view and judgement of the behaviour.

1.5.3. Interviews

The interviews will be hold as semi-structured interviews. The selection of the interviewees are people who are employed or formally employed by Radboudumc. The describtion of the selection can be found in the Case Selection for Validation. Goal of an interview is that the interviewee share as much as much information as possible, unselfconsciously and in his or her own words (DiCicco-Bloom & Crabtree, 2006).

An interview guide of written list of questions and topics according to Bernard (2006) will be used. The goal of the interview guide is to create an environment where the respondent feels free to share their knowledge and also that the interviewer will be objective in the questioning. The semi-structured interview will involve a set of open-ended questions that make it possible for an in-depth reaction. (Baumbusch, 2010)

The named methods can have shortcomings in their validity and reliability when they are pore performed. To prevent most of the shortcomings these need to be identified.

The observations and interviews can have a researcher bias, which is a threat for the validity. Baker (2006) mentioned three types to minimize the threat. Face validity is a logical examination if the observation is plausible or make sense. The second is the criterion validity, which is covered by using the methodological triangulation. Lastly is if the observation fit in the existing research and theories, it is the construct validity. The construct validity will be ensured by the literature review.

Another threat can be the reliability of the data, this will be ensured by repeating the observations and interviews. The archival documents will also be used to make the collected data more reliable. Yet the research has a strict and tight time frame, there it will not be possible to repeat every interview or observation.

1.5.4. Usage of data to build construct

To build the construct secondary data from literature will be used. The construct will be tested with the quantitative data of the hospital, but the validation will be performed with the qualitative measurement of evaluating the prototype. This will be validate with the users, which are the departments PVI, BIA and Advisers of board of directors and de board.

The validation measured if the prototype of the construct of an MIS can give the insight the Board of directors and involved employees need to monitor the efficiency of business capacity. This will give a answer if the construct can give insight in the efficiency of business capacity of the academic hospital Radboudumc. This limited the result to one hospital within the Netherlands. Thus is the external validity of this research is weak. Also the internal reliability is at risk, because it will be observed by only one person and the internal staff members will be supervising this research. Yet the prototype will be also compared to the literature construct with the purpose to strengthen the internal reliability and also the external validity. Also like Robert K. Yin (2013) states that the analytic generalization should aim to apply to other concrete situations. Thus in this research this would be other academic hospitals in the Netherlands.

1.6. Expected results

The expected results of this research are to give a construct of how to design indicators for a management information system. The indicators should represent the efficiency of business capacity . Those indicators should be aligned with the organizational strategy of internal process and monitor departments. To use the strategy developed by the managers this approach assumes the involvement of the management. The results should also support the hypothesis, which states that the transformed hospital data can give enough insight in the business capacity.

This will add more knowledge to the literature about management information systems for health care and hospitals. This will be hopefully generate opportunities for different academic hospitals to monitor their efficiency of business capacity.

1.7. Deliverables and Scope

The Deliverables of the research:

1. Problem identification
   1.1. The definition and requirements of the research formulated in a clear problem statement. (Research question and objective)
2. Objective of the Solution (literature study)

2.1. A literature selection and study about cases, models and theories concerning the problem with an objective of the solution

3. Design and Development
   3.1. Design construct
      3.1.1. A theoretical construct of existing theories how to build and generate an information system for an academic hospital
   3.2. Testable construct
      3.2.1. A construct which includes measurable and dimension which should be monitored to achieve/ maintain the efficiency of the operational business capacity and volume
4. Demonstration: Prototype of the testable construct
   4.1. A prototype with Tableau will be generated, this means that an interactive dashboard can be tested. This will be built on the data sources from the Radboudumc therefore it can be implemented in their own
5. Validation of the testable construct
   5.1. A realisation validation which test if the data and information are available for the prototype
   5.2. A second validation will be held with experts on the topic, in the topic the strategic insight will be measured. This last step will be done in a iteration, therefore the prototype will be used to test the data model with the experts. Therefore it will be happening at the same moment than the step 4 "Prototype of the testable construct"

1.7.1. Scope of the research

The research considered only internal process values of the departments which can be compared between the most department. Therefore the following sub-departments are included: Outpatient Clinic, OR and Clinic (Day Treatment).

Furthermore this research excluded the financial situation of a hospital in the design of the construct and also in the development phase of the construct and the dashboard. For this approach was chosen, because the financial information cannot be directly related to the internal process information. (The financial flows can be delayed from three to six months, which makes a direct comparison almost impossible.) This is an insufficiency of different variables like the data model and also the complexity of the financial path of healthcare procedures.

Another difficult factor is the satisfaction of the patient, this is one of the strategic values of the Radboudumc, yet this is difficult to monitor frequently. And yet there is not yet an option developed by Radboudumc to measure the patient satisfaction in a quantitative ways which can be translated to a direct process, sub department. (The hospital is using patient information to monitor the satisfaction)

At this moment the learning and growth of the employees are also hard to directly monitor. Also the learning and growth concerning research and education is not yet measured in a weekly or monthly frequency. (This finds place in a more abstract way)

Therefore the focus is on only the operational excellence of the capacity of rooms, capacity of beds, amount of patients and visits.

1.7.2. Validation of the Testable Concept

The testable concept will be validated in two steps. The first will test if it is realisable, thus is the needed data registered in the system and also accessible. If the values fail the first test they cannot be included in the prototype.

The second step will be to conduct semi structured interviews with experts on the topic "strategic insight in the efficiency of the operational business capacity and volume of an academic hospital" These experts are identified in cooperation with the owner of the business case and a consultant of the internal consultancy PVI.

The Design science approach of Pfeffers et al.(2007) is chosen for this research. Yet the evaluation phase was abandoned and the validation phase of Wieringra (2009) was used. Therefore further his approach of the validation is used.

According to Wieringra (2009) to solve practical problems the goals of the stakeholders needs to be investigated and the development of solutions should involve the stakeholder criteria's. In his design science approach he also used a cycle to develop solutions which is similar to the Pfeffers et al.(2007) DSRM process model.

Wieringa (2009)defines three questions which should be answered in design validation. He defines those questions as knowledge questions. These are: according to him:

V1. "Internal validity. Would this design, implemented in this problem context, satisfy the criteria identified in the problem investigation? This contains two sub questions.
    E1 Causal question: In problem domain D, would solution S have expects E?
    E2 Value question: Do E satisfy stakeholder criteria C?
V2. Trade-offs. How would slightly different designs, implemented in this context, satisfy the criteria?
V3. External validity (a.k.a. sensitivity analysis). Would this design, implemented in slightly different contexts, also satisfy the criteria?"(p. 4-5, Wieringra, 2009)

About question 1 this research problem is a value question and not a casual question. There the question would be: "Do E satisfy stakeholder criteria C?" In the problem definition it was stated that the "E" needs to be identified which is the indicators within the artefact or prototype. Although the criteria "C" is a perception value, which therefore will be qualitative assessed. The first four open question were formulated to answer the question. "Do E satisfy stakeholder criteria C?" . The open questions are formulated to gain insight in their perception of the "operational business capacity of the volume and the efficiency", the importance of the additions to the monitoring process and also which values the interviewed experts is missing. During the presentation the interviewee, can give direct feedback over the indicators in the prototype and give answer if those values are informative. After this there are two questions asked about the prototype. The questions want to identify if there are new, added information insights. This question is asked to investigated of they see an added value in such a monitoring tool. The last question is asked about information they are missing. In that context it is stated that this is not related to the current registration, or available measures. This is a question for values they are desired. The last question was to use the "V2" of Wieringra (2009) . In this approach the interview could create or state their own trade-off by describing their ideal version.

These Experts which will be interviewed are business manager within the Radboudumc, Consultants of the department PVI, Manager of the Department BIA, Manager of the Department PVI, Information Analyst, Business analyst of the Anaesthesia, Director Finance, a the external advisor, member of the board of the directors at the Radboudumc. This is more detailed described in the section "case selection of the validation".

Also the construct validity will be assessed, by investigation if the results fit in the literature context of this research field. This will be later discussed.

2. Objective of the Solution: Literature study

The objective of the solution according to Pfeffers et al. (2007) searched literature for feasible and possible solutions and for similar situation. In the literature selection method the criteria's for this part are explained. In the problem identification the need for a "system" which can provide the board of directors of the hospital with the information about the efficiency of the operational business capacity and volume is described. This problem is quite distinct. Also is in the literature search it is chosen to start with a broad search to explore the background about similar topics and information's. First the business capacity will be defined, which is expected to be a difficult task. Then business capacity and volume will be defined and the options how to measure the efficiency of it.

After this it the literature study will give an answer to the first sub question about strategic insight. Then the management information systems in hospitals will be researched to give answers to the second question and develop into a solution or approach to identify strategy to operational procedures. This information will be used to develop the design construct.

2.1. Business capacity

The search for information about business capacity was a difficult task because this term may be too specific. Yet there was information found about the business capacity in hospitals.
It was included in the problem statement of this research. The business capacity which was meant in the problem statement is, that the business capacity is the amount the hospital can hold concerning the primary patient care process. Amount describes the duration, the available space, staff, methods, tools and other resources related to the primary patient care process. It was only literature found which does not focus on business capacity but used it for different approaches or capacity planning.

Vanberkel and Blake (2007) developed a model to reduce the waiting time. This is achieved with a proper resource allocation and sound capacity planning. It is stated that the generalized capacity planning model is often assumed that the current resources are achieving maximum capacity. They define capacity as the ,number of surgeons, ORs, number of beds available, OR time and LOS. They simulation had an interesting outcome: "The simulation showed that long wait times are more dependent on beds than available OR time. This conclusion provided direction to focus on alternatives that free beds to reduce the effect of the bottleneck.(pp. 384 Vanberkel and Blake,2007)

Table 2 – Definition of capacity

Vanberkel and Blake (2007)	Santibáñez, Begen, and Atkins (2007)	Akcali, Côté, and Lin (2006)
- Number of surgeons - ORs - Number of beds available - OR time - LOS	- OR availability - Bed capacity - Surgeons availability - Wait lists.	- the amount, capability, cost, types of available or desired resources - patient length of stay - likelihood of full capacity where all inpatient beds or examining rooms are occupied - utilization of providers and facilities, and financial performance

Santibáñez, Begen, and Atkins (2007) wrote about how the surgical blocks in a medical facility is complex because of the variety of surgical specialities. They developed also a model to explore the values of OR availability, bed capacity, surgeons availability, and wait lists. In their article the

capacity of the OR is described as the OR room availability, surgeons availability, the block capacity and the number of surgeons. Their model is developed to reduce the waiting lists, they advise doing so by open op more blocks within the OR's.

Akcali et al. (2006) describes that a successful health care capacity planning must address, the duration of the planning horizon like operational, tactical and strategic. Also the level of care is an important factors, which is differentiate between primary, secondary and tertiary and if the patient is inpatient or an outpatient. For the network flow approach to optimize bed capacity planning they used the information about bed capacity and facility performance and budget constraints.

Within the literature there was not an overall definition found of the business capacity of hospitals. Nevertheless the definitions about capacity are similar. Vanberkel and Blake (2007, Santibáñez et al. (2007) and Akcali et al. (2006) mention all the capacity of beds and two mentioned length of stay. It is in some cases described with the capacity planning which is only described for the Operating room or to the bed planning of an hospital. Therefore the definition of the Radboudumc is used. This definition is there is a differentiation established of the potential capacity, available capacity, useable capacity, used capacity and the productive capacity. (personal communication, L. Berrevoets, 24-8-2015)

Also in the interviews with the eight internal experts and the one external experts it was coherent answered that the efficiency of the business capacity and volume is: "To use in an efficiency way the available time, materials, room, people to achieve the right outcome." The meaning of this is clear within the hospital. This definition will be further, when it is referred to the business capacity and volume and the fourth sub question is answered (What is the operational business capacity and volume?)

The first sub question was : *"What is the operational business capacity and volume?"* The operational business capacity and volume describes the values are generated in the primary process of the patientcare of the Radboudumc. The volume describes the amount of patients, visits, operations, day treatment, inpatient days et cetera, which are parts of the patientcare process. The operational business capacity describes the available capacity and the realised capacity of the materials and resources of the process. Those are the doctors, medical staff, rooms, OR rooms, beds.

2.2. Strategy and strategic alignment

The strategy of a company is the plan for the future direction and intended goals and how to achieve the direction and goals. The next step is to link the strategy to the business structure and in the business operations. To find out if the strategy is implemented there are theories about identifying the strategic alignment. Mintzberg (1978) defines strategy as a deliberate conscious set of guidelines that determines decisions in the future. He addresses that it is important to differentiate between the intended and realized strategy. With the theories about strategic alignment, is will be investigated if the intended strategy is according to the realised strategy. Also this research acknowledges that the strategy is not a fixed plan where the changed can be systematically be planned (Mintzberg 1978)

This research focuses on the reporting about the operational excellence of the efficiency of business capacity and therefore the IT alignment is an relevant topic. Bergeron, Raymond, and Rivard (2004) described the fundamental view of strategic fit as the search for aligning the organization with its environment and arranging the resources to support that alignment. They reasoned that firms would then be less vulnerable. The information processing according to Bergeron et al. (2004) was used for organizational decision making and as framework for better understanding the fit between strategy and

structure. So the IT strategy and IT structure should be also aligned with the strategy to support the structural fit.

Venkatraman (1989)developed a set of 29 operational indicators to measuring the difference along a set of characteristics that collectively describe the strategy construct. The list of indicators is called strategic orientation of business enterprises (S.T.R.O.B.E). Bergeron et al 2004 used the same list to find ideal patterns between the Business strategy, Business structure, IT strategy, IT structure. They developed construct to identify the Business structure, IT strategy, IT structure. Their assumption was that if the Business structure, Business strategy, IT strategy and IT structure are not aligned the financial and non-financial performance would be lower than if there are aligned.

Avison, Jones, Powell, and Wilson (2004)describes four different types of strategic alignment, those are fit, integration, bridge, harmony, fusion and linkage. This research focuses on the linkage. In their (Avison et al., 2004) literature review they found out that IT is often treated as an expense rather than as an enabler of business value. In their study their researched the completed projects, IT and Business strategy documents and project prioritisation to identify the strategic alignment. This approach is not relevant for this research because the focus is to identify the current state of the academic hospital. It is desirable to enhance the IT technology usage but it is not the focus.

The purpose to identify the alignment is to measure the current situation at the academic hospital. If there is a strong alignment the academic hospital realised strategy is according to their indented strategy. Therefore the focus of the used BSC will be on maintaining that alignment. If the alignment is weak it would be desirable to use the BSC to improve the alignment.

What is strategic insight and how to identify it? First there are differences between the realised strategy and the indented strategy. The indented strategy should be defined by the company in their vision and mission. The S.T.R.O.B.E test will be used if the indented strategy is realised and how this is achieved and communicated. Also later on in the results of the dashboard it should be seen in the data that the indented strategy is realised.

This part answers the second subquestion. *"What is strategic insight and how to identify it?"* Mintzberg and McHugh (1985) described the strategy as a set of guidelines that determines decision in the future. The method of Venkatraman (1989) was used to identify the strategy alignment in the Radboudumc.

The hospital has a strategy communicated through the company. This strategy gives each health care department freedom and independence to choose their own path. They have only guidelines about the 4 pillars and the three primary process streams as education, research and patientcare. (this is described in detail in the chapter 3.1 Radboudumc)

2.1. Information Management in Health care

The first observed challenge about information management in health care were technical problems with dealing with information. These technical problems were old equipment's, poor program performance, the lack of access and also poor management of applications (Tsay & Stackhouse, 1991). Back then the use of management information systems where required, yet Tsay & Stackhouse (1991) did not go into detail about the importance. In time different challenges occurred to Osama, Nassif, Capretz (2013). They stated that hospitals collecting huge volume of data and that the new challenge is how to deal with the raw data and how to transform it to meaningful information. Meaningful information is information where executive leaders can base their decision making on, because it gives

them insights on what is going on now and how to predict what will happen in the near future (Osama et al, 2013). Chaudhry et al. (2007)reviewed literature about information technologies within health care. They conclude that the benefits of health information technology in theory are clear yet there is lack of data about implementing the technologies within health care.

Finally there is a paper of Ramani (2004)which describes how to design a MIS within government hospitals in India. He designs performance indicators which he concluded are useful to plan and monitor the efficiency and effectiveness of the hospitals in India.

The discussed studies are consistent that information technologies can be used to support health care in efficient and effective ways. Notwithstanding the research of Ramani (2004) is limited to only a set of performance indicators. The develop systems is concentrated on reducing cost and does not support a clear management style or strategy.

The identified research gap is how to design a management information system for the efficiency of business capacity in health care which is aligned with the organizational strategy and monitors all departments and ensures the involvement of the management. 1

2.2. Management information systems in Health Care

Management information systems (MIS) have an almost self-explanatory name. The purpose of such a system is to provide the management or the governing body with the information they need to manage or control a company. Within the problem definition of the research the was a need identified for a "system" which gives strategic insight in the operational business capacity and volume.

Therefore there was a literature study done on the topic of MIS in hospitals. The intention was to find out which methods, systems, tools or information are used in a MIS for hospitals. An ideal MIS provides information about the whole company or in this case hospital. Therefore information systems which are generated for specific departments, medical specialty, one medical condition are not relevant for this problem statement.

Applegate, Mason, and Thorpe (1986) wrote an article about the need for hospitals to have information systems which can cope with internal and external information and have an emphasis on strategic hospital planning. They identified in their observations of planners that here is need for three models a decision component a model component and a data component. The decision component has three sub categories organizational performance analysis, expansion of existing service or new venture analysis. They identified the need for additional systems and developed a strategic planning framework: "Hospitals must attempt to provide the most attractive package of services at the least cost. And the current state of technology in most hospital information systems designs are needed to cope with the changes in the economic structure of the health care industry and its effects on hospital information needs"(p. 88, Applegate, et al., 1986)

Pierskalla and Woods (1988) identified the barriers of information systems which are the special distribution of patient utilization of hospital facilities and the reluctant adoption of systems of the clinicians. They assume that in the future it would be possible to make al link between the two have integrated information systems. Also they listed values which should be included for market planning. Using the information, different units at the management level construct models based in statistics, operations research, management science, expert systems and perhaps in the future artificial intelligence to support an make strategic divisions concerning the direction of the hospital.

Administration systems were the first to be instituted in the hospital (financial focus) the greatest all around information systems and DSS growth in the 1970 and 80 are the patient care systems.

Forgionne and Kohli (1996) find out that Management support system can improve decision making outcomes in comparison with Decision support system. The MSS is a synthesis of the standalone systems within the hospital .By deploying the systems effectively support the segment for the hospital decision making process

Curtright, Stolp-Smith, and Edell (2000) did research for the outpatient at the Mayo clinic. They faced the challenge of creating a healthcare system which measures performance in an environment which has an increase in complexity. The system should align organizational strategies and core principles with performance measurement and management indicators. In their search for developing a measurement framework they used the balanced scorecard of Kaplan and Norton to access performance across both financial and operational indicators. They developed a list which was mainly based on the BSC but also on other literature. Those are:

- Customer satisfaction: internal and external customers
- Internal business processes: efficiency of operations
- Quality of service or products
- Continuous improvement efforts
- Public responsibility and social commitment
- Financial performance

Bose (2003) develops the outlines of a systems which integrate clinical, administrative and financial processes in health care. This is designed with a common technical architecture. The emphasis of this design it that the clinical and administrative information is needed for decision making. The interesting requirements for this systems are the interface of the MIS integration of system data, personalisation of contents, content management, search for navigation, classify access to the resources and BI tools for turning the business knowledge into an advantage. Yet there is no clear information if that could be benefit to the strategic management decision.

Andersson, Hallberg, Eriksson, and Timpka (2004) their research focused on how to develop a conceptual model of a management information system for process oriented organizations. In their approach and development they used the BSC, TQM for the quality management and a PDCA cycle for the patient focus. They identified that the hospital management needed a system that support both models as TQM and BSC. The MIS system should also include the medical information, nursing care of patient, the patient flow and the use of human and material resources. One of their findings include that little attention had been paid to the integration of systems. Therefore in the current case study's they find out that the administrative, financial and clinical systems were not optimal configured.

The article of Wyatt (2004) suggested that the BSC should be supported with an visual dashboard to monitor the performance values. Also these visual dashboards should be accessed within the organisation to inform them about the status of the KPI. He also pointed out the importance of the collected data and uses these to compare to historical trends and industry benchmarks. The visual dashboard should give manager the ability to drill down to find the root or cause of problems or a warning. Also the further analysis should help the manager to assess the potential impact on the budget and determine the priorities.

Naranjo-Gil and Hartmann (2007) their research focus on the background of the CEO and their decision making. This objective is not explicit relevant to our research topic. Yet they used an management information system in their research. Their findings showed that an CEO's with predominant clinical background focuses on non-financial information and prefer an interactive style of using a MIS. CEO's with a predominant administrative background use the MIS in an diagnostic way and focuses on cost reduction strategy. It was then expected that they use of the MIS would be influences the implementation of the strategic goal.

Bose (2003), Pierskalla and Woods (1988) and Forgionne and Kohli (1996) found out that information systems have barriers because the systems are "stand-alone" therefore are syntheis of the system would be optimal for analysing the information(clinical and administrativ) of an hospital. Applegate et al. (1986) lies also emphasis on the need for more insights but lies the focus even outside the hospital. Curtright et al. (2000) also stated that external information is needed to manage a hospital.

Curtright et al. (2000) and Andersson et al. (2004) describe both the development of a management information system which could cope with the different aspects of an hospital an choose therefore on the BSC but added the needed perspective of healthcare in to that framework. And also Wyatt (2004) describes a case were the hospital used the BSC to cope with the need for performance data and adjusted it to the hospital needs. Naranjo-Gil and Hartmann (2007) lay emphasis on how the MIS will be used and which strategic goal it will support.

In this phase of the literature study it was not searched for indicators or KPIs for the development of the BSC and framework. Yet some article had some indicators which were relevant for the further steps. The whole list can be found in the Appendix J. Those are 49 different indicators mentioned by the authors Applegate et al. (1986), Curtright et al. (2000), Naranjo-Gil and Hartmann (2007), Pierskalla and Woods (1988), Wyatt (2004) and Curtright et al. (2000) which should be included in an MIS. This gives an indication how complex the process of selection of KPI's is. They also do not agree on the amount of indicators. The variation lies between six and 16.

2.3. Balanced Scorecard (BSC)

The requirements for this research problem were to develop an construct which gives a strategic insight in the efficiency of the operational business capacity and volume. In the literature about MIS in Healthcare two articles described the use of the BSC for they MIS. (Curtright et al., 2000, Andersson et al.,2004). Therefore it was analysed if the BSC would be a fit for this research objective. In the first phase the literature about the development of the BSC will be discussed.

The BSC (Kaplan& Norton 1996) has the focus on related the strategy to their performance measures and outcome. Kaplan and Norton (1992)defines four perspectives to keep the balance of the scorecard. These differentiation focus on financial and non-financial performances. The strength of this model according to Kaplan & Norton 1996 is that short term, long term objectives, soft and hard objective measures will be taken into account. The four perspective are Financial perspective, the customer perspective, the internal Business process and learning & growth.

The approach of the BSC was in 1992 a new way of managing a company. The notably distinctions about this approach was forward looking perspective, integration of external(customer perspective) and internal measures. The model is based on a mix of core outcomes measures and performance drivers. Norton and Kaplan (1996) state that outcome measures without performance drivers do not communicate how the outcomes are to be achieved. In their first article in 1993 Kaplan and Norton

describe the importance to have the diagnostic measures that monitor if the organisations stays in control, but have also the strategic measures that describe the strategy designed from the company to achieve competitive excellence.

In 1996 Norton and Kaplan describe it as a cause and effect hypotheses among objectives and the business can test if they try to achieve with their performance drivers the desired outcomes described in their strategy. If there is no clear linkage between the driver and the outcomes it can be assumed that their do not achieve what their designed in their strategy. The BSC is a strategic tool therefore it is not a replacement for the day to day measurement system, but also it does not provide indication about whether the strategy is being implemented successfully.

Furthermore the BSC was implemented and critical accessed by other authors. Otley states that the determination on how to map necessary patterns in the balanced scorecard perspectives is a complex and time consuming task. Also is the Balanced scorecard more an stakeholder approach, which is an advantage of the tool but also has limitations. The chain of events that Kaplan and Norton uses in their BSC defines Otley as a simplification of the reality. He mentioned that in which approach are the trade-offs defined between the different used measures. Therefore the question rises in how balanced is the scorecard. Otley (1999) argues that only the organizational relevant indicators can be found in the BSC. The BSC has as on advantage the dynamic of the tool. It has to be changed when the strategy changed. Otley (1999) values that on the tool, yet he states that the double loop learning is not specific included in the model. This would help to verify if the model is working. The BSC is not an isolated tool it should be supported by the traditional used systems of an organization.

Nørreklit (2000) and Otley (1999) agree on the lack of external values. (Nørreklit, 2000) states that the monitoring of the completion or technologic development is important for a company to stay competitive. Nørreklit (2000) states" The crux of the balanced scorecard is the linking together of the measures of the four areas in a causal chain which passes through all four perspectives. (p.67)"

The BSC of Kaplan and Norton state that financial measures represent the pats and non-financial measures drive the future. This is an assumption according to Nørreklit (2000) which is based on that the cause and effect relationship exist between the perspectives and the measures. Their state also that empirical observation is not enough for a company the accounting calculus is crucial, but the BSC is also only support for strategic tool not a replacement for accounting methods.

One important fact Nørreklit (2000) state is the time lag between cause and effect. The values are presented in the scorecard have time differenced . (it was involved in this model a time dimension) They also identified that the causality between quality and financial results is lacking and that the relationship is instead logical. And is develops not only in one direction but the reasoning is circulate and the relationship of the four perspectives are interdependence. Nørreklit (2000) also concluded that the model is a top-down structured and therefore hard to be rooted in a dynamic environment.

Ittner, Larcker, and Randall (2003) did a quantitative analysis about the use of financial and non-financial measures and the positively association strategic performance measurement. They findings support that firms which use more extensive broad set of financial and non-financial measures earn higher stock return. Yet they did not find evidence that the strategic performance measurements systems are associated with accounting measures. Nevertheless they found positively association with alignment techniques and the association with measurement system satisfaction.

The limitations that the BSC is not a replacement for the accounting calculus like Nørreklit (2000)stated is not applicable for this research, because the BSC is used for additional information. Also this research is not considered to evaluate the implementation of the strategy with this tool.

The most concerning limitations are the trade-off of the measures with Otley (1999) mentioned, the external values and last the time lag. The trade-off of the measures will be controlled by communicating with the stakeholders. The time lag of the variables, will be considered in the model. External values should be taken in account.

In consideration of the limitations and advantages of the BSC method it complies with the overall need for information contribution and estimation of relevance information. Yet it cannot completely be decided if it fits and support the organisational structure needed within the healthcare approaches. Therefore it will be discussed in a healthcare approach in the next part.

2.3.1. Balanced Scorecard in Healthcare

This part evaluates the research findings about the BSC in health care. The main articles about the BSC were selected and in the last part the indicators of the BSC will be discussed.

Chow, Ganulin, and Haddad (1998) describe the BSC as a customer based planning at focusing and driving an organizations change process. In their results they found out internal business perspective goal is cost control, which led to the logical conclusion that one measurement can relate to multiple goals. In their result they also lay emphasis on guidelines and the unique set of circumstances that makes the BSC should be developed with the unique circumstances.

> "Guideline I: The performance measures(s) selected should be positively related to degree of attainment of the related goal; as the latter increases, the former also should increase.[…]
> Guideline II: Not all the performance measures should be focused on outcomes. Performance drivers also need to be included to serve as leading indicators of outcomes. […]
> Guideline III: The number of performance measures should be kept low so as not to diffuse attention and create confusion. […]"(p.7, Chow et al.,1998)

Zelman, Pink, and Matthias (2003) describes the BSC as a useful tool for health care. They stated in the article from 2003 that the found about 142 articles on the BSC in period from 1999 to 2001 (This search was refreshed in a comprehensive way with the search database Scopus, which found about 2730 articles, and the peak was in 2011 with 293 and from the year 2001 it is steady growing to about more than 150 articles). They concluded that the concept of the BSC is relevant to health care, but need modification to reflect the industry. The perspectives they find commonly added is the quality of care outcome.

Peters et al. (2007) have developed an BSC for their own purpose, they have identified six domains: patient perspectives, staff perspectives, capacity for service provision (structural inputs), service provision (technical quality), financial systems. They found out that the BSC has a contribution to the increasing transparency in health sector and enable manager to identify and address of Areas of weakness.

Grigoroudis, Orfanoudaki, and Zopounidis (2012) did research about the valuable KPI's within an hospital. They state that the BSC is management system which provide the organisation a tool to translate vision and strategy into actions. The development of KPI's is complex due to that the complete understanding of that value is important and target values need to be identified. In the

research of Grigoroudis et al. (2012) they found within each perspective two important value for that one hospital. (Development of the KPIs supports the alignment of individual departments or employees, because they are known were to focus on to achieve the most important improvements)

- Financial:
  - current ratio (30.92% importance)
  - inventory turnover (33.92 % Importance)
- Customer perspective
  - patient satisfaction index 23.92%
  - average duration of hospitalisation 39.35%
- Internal Business perspective
  - the surplus inventory (62.40%)
  - bed occupancy ratio (19.79%)
- Learning & Growth perspective
  - resource allocation to information technology/capital (64.45%),
-

ten Asbroek et al. (2004) researched how the BSC could be useful for an National healthcare approach in the Netherlands. The linked the BSC to the Lalondes health model thus that the relationship between population health and health system management can be made. The need for such a framework was identified by the Ministry of Health, Welfare and Sport to monitor the health system performance in the Nederlands on a national level.

Oliveira (2001) discussed the importance of system data to fill the BSC. Also he argues that the financial indicators which are the main values in the system, give only information about past performance and allowed only a sort term view of the strategy. The Kaplan and Norton (1996) values outcome (lagging) and driver (leading) were used in his model. The emphasise on the driver indicator is in the approach and creating of the BSC specific distinct, because according to Oliveira (2001) this is the option to build capabilities to improve performance. The concludion remark is that the the BSC helps to integrate hospital performance on a strategic and tactival level.

Above al researchers agree on that the BSC is a usefull tool for the healthcare sector. Zelman et al. (2003), Peters et al. (2007) and ten Asbroek et al. (2004) agreed on that the original version of the BSC should be changed to an health care vision. They used different approaches, where ten Asbroek et al. (2004) used another model to include external values and did not changed the main BSC perspectives. Below in the figure 2 it is shown that four authors did not change the perspectives at al. Exepct Peter et al 2007 al of them used only four diemensions. (The complete list of perspectives and KPIs used in the paper can be found in the Appendix J) In the image below there are Hwa, Sharpe, and Wachter (2013), Bamford & Chatziaslan (2009), Pink et al. (2001) and Türkeli and Erçek (2010) Their articles are discussed in the next chapter.

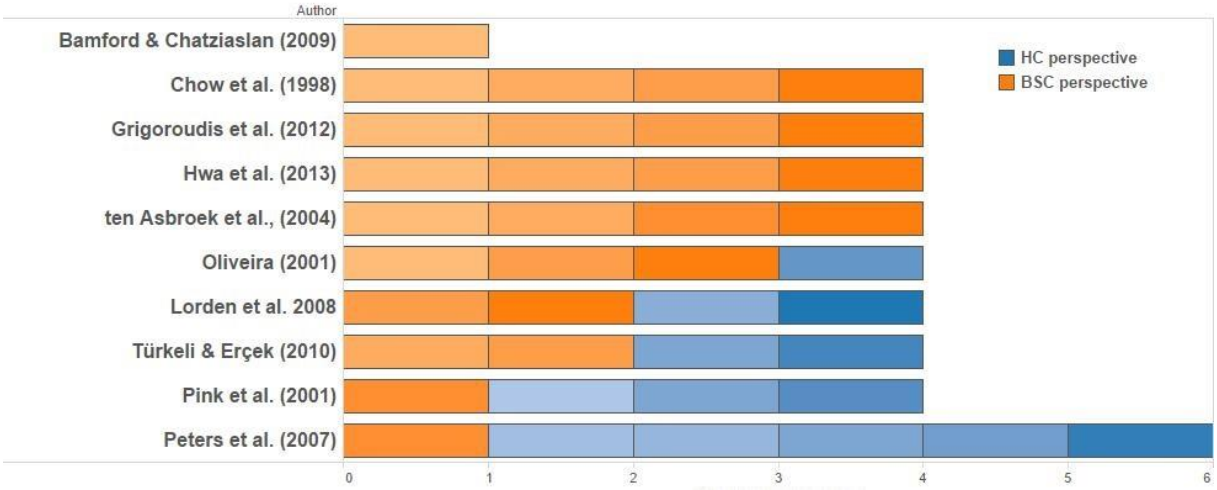


Figure 2 – Overview of chosen perspectives within the literature

Pink et al. (2001) changes the definition of three of the perspectives to fit it more to the hospital needs. Lorden et al. 2008 and Pink et al. (2001) all three changed the Internal Process and Learning and growth perspective. Türkeli & Erçek (2010) changes the Internal process perspective to clinical focus and Oliveira (2001) changes the learning and growth perspective. Therefore the customer perspective is most often changed, and four times the internal process and learning and growth is adjusted. The financial perspective is used by al authors and not changed. The selection and description of the ideal balanced scorecard based on this information can be found in the ideal balanced scorecard part.

Chow et al. (1998) and Oliveira (2001) both have more emphazise on the importance of drivers within the BSC. But Oliveira (2001) destinked describes the relationship between the KPI's.

2.3.2.BSC implemented in Hospitals

In this section case studies and action studies are described which implemented the BSC or an approach based on the BSC in an Hospital or an Hospital group. The experiences an methods are compared and evaluated.

Pink et al. (2001) used the original version of the BSC from Kaplan & Norton 1993 and adjusted it to fit the health sector to use it for 89 hospitals in Ontario in Canada. They chose to change the original four perspectives into four new one. The precise change can be viewed in "Tabel 3".

Table 3 – Pink et al. 2001 BSC in HC

The four balanced scorecard perspectives of Kaplan and Norton	As adapted for use in a publicly funded health service setting
Financial	Financial Performance & Condition
Customer	Patient Satisfaction
Innovation and Learning	System Integration and Change
Internal Business Process	Clinical Utilization and Outcome

The implementation process is only described for the financial perspective. They divided the implementation process in four steps and used the knowledge of a Financial advisory panel of experts which was related to the project volunteered to support the implementation.

Another five cases were found where the original BSC was implemented those are Pink et al. (2001), Lorde et al. (2008), Bamford & Chatziaslan (2009), Türkeli & Erçek (2010), Hwa et al. (2013). Bamford & Chatziaslan (2009) built their own model of the AFM based on the BSC the others filled

the perspectives in for their purpose. Each implementation of the BSC is different in their enforcement. They used a step approach, or implemented the BSC partly or built own frameworks of them. The involvement of experts, or users or departments (stakeholders) in each implementation were a relevant aspect. Nonetheless two studies had issues with keeping the stakeholders involved and interested. Türkeli & Erçek (2010) had resistance with their implementation due to involving and identifying needs of the users (top management, hospital staff). Lorde et al. (2008) had to struggles with the management transparency and the lack of leadership to support their implementation.

In the literature about the implemented case an action study's it is noticeable that the motivation of the implementation of the BSC by implementation in a hospital are driven by financial factors. (Lorde et al.,2008, Bamford & Chatziaslan, 2009, Türkeli & Erçek, 2010)Other motivations are that the BSC is a useful tool for hospitals because of the complex organisation structure of a hospital and that therefore performance should be measured with more than a single measure (Pink et al., 2001) The motivation of the academic hospital groups is that they should excel in multiple domains (Hwa et al., 2013)

To support the importance of transparency in the studies of Lorde et al. (2008), Bamford & Chatziaslan (2009), Hwa et al. (2013) there used web-based information services or in Pink et al. (2001) situation a yearly report which was shared under the hospital. In the case of B&C their systems appeared to*:* "increase the confidence of the clinicians in performance information, improve the transparency and form the basis for common understanding" *(*Bamford & Chatziaslan, 2009, *p. 732)* between the organisational levels. The system was only implemented partly but the hospital identified the need to implement the whole (strategic) BSC.

In the case study of Lorde et al.,(2008), they could achieve the increase in the patient satisfaction which was the developed perspective of the BSC. Unfortunately this could not help the hospital from their financial failure and it had to be closed.

Pink et al. (2001) did find essential guidelines to create and report measurements. Those are the quality of data and the definition and meaning of information. The experts in their financial advisory panel had more priorities on relevant indicators than commonly known indicators. Also the information is political and cannot be easily shared, also are hospital not simple to compare because they allocated the resources different. If the comparison of information can be achieved it is valuable indication. In view on the quality of data, Pink et al. (2001) did find out that presenting data is important as data itself, that linkages between them are hard to build and that lack of data, the correctness and the credibility is a concern.

In the research of Hwa et al. (2013) they achieved to developed 16 key indicators which gave them a broad view of their performance of the hospital group. This indicates ensured that the group uses the data to guide strategic decisions and also translate this strategy to the division. After the implementation they observed that the their divisions had a shared vison. Also each faculty could now see that their individual effort can influence the performance of the whole group. Hwa et al. (2013) stated that the discomfort to share data should be handled carefully and that this issue should be anticipated and discussed. They plans for the future are to "choose metrics that will not simply measure performance but drive it"(Hwa et al, 2013, p. 153)

Of the above described studies only two of them implemented the internal process perspective of the BSC. Hwa et al.(2013) divided the in two sectors: Improve Quality and Safety of care and Improve Cost and Efficiency of care. The indicators for Improve Quality and Safety are 6 indicators (Mortality

Index, All 30 day readmission, Timely follow up after discharge, PCP communication at Discharge, Hand hygiene Rates, Pneumonia antibiotic selection) and for Improve Cost and Efficiency of Car there were two(Length of Stay, Direct Cost per case) And Bamford and Chatziaslan (2009)developed measures for the senior management, middle management and the Clinicians of the Internal process. (Senior management: Capacity utilisation – strategic performance targets, Financial data (cost per clinic), Fit with clinician's annual assessment, Activity targets)

The research articles give relevant information on how to implement a BSC in a hospital setting. Their findings, obstacles and limits will be considered in the designing of the BSC for this case. Upfront can be concluded that the measures of the two studies which include the internal process perspective will be consider in the selection of the measurements.

The BSC in this aspect will not be used to implement or develop a strategic. These is manifested and developed which is acknowledged in the chapter Strategic alignment of Radboudumc.

Also the issue of transparency will be acknowledged and considered in the performing of this design science research. The designed BSC should be woven around the culture of the Radboudumc that it will not have to deal with resistance and also the existing reporting systems and the acknowledged measures will be included.

2.3.3.Ideal Balanced Scorecard for the internal process

In the literature study there came a number of indicators within a BSC across. There were indicators within the MIS literature, the BSC in Health Care and also in the implementation process of the case study's. There were 247 different indicators. This also shows the different possibilities and applications and also that hospitals have different vision and strategy's which were the ground for the development. After an extensive comparison the four perspectives were combined. It is noticeable that the patient perspective has more indicators than the financial perspective.

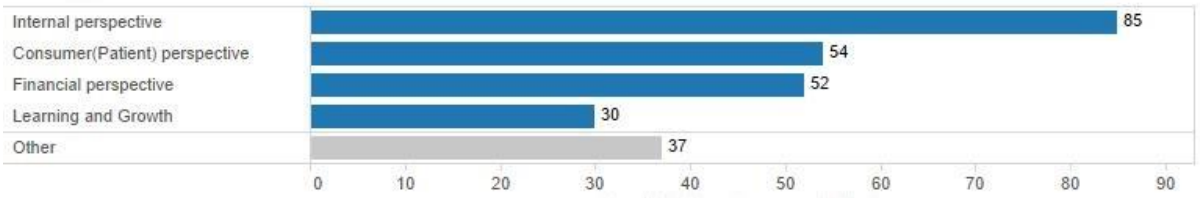


Figure 3 – Perspectives and the amount of Indicators

This research focuses only on the internal process of the BSC. Therefore the 85 indicators were analysed and compared with each other. Some indicators had the same meaning in different words or had a relation with each other. If they had an relationship there were grouped together. Therefore it was possible to combine 42 indicators to 8 values. These are presented below in the figure. (It should be noted that the article of Pierskalla and Woods (1988) does not include the BSC, but their indicators are quite similar to the indicators found in the BSC articles. Thus it was choosen to include them in the indicators for this model). It can be seen that the authors Applegate et al. (1986), Bamford & Chatziaslan (2009) , Chow et al. (1998), Curtright et al. (2000), Grigoroudis et al. (2012), Hwa et al. (2013), Naranjo-Gil and Hartmann (2007), Oliveira (2001), Pierskalla and Woods (1988), ten Asbroek et al., (2004), Wyatt (2004) were included in development of the perfect internal process KPI's. Therefore only 5 authors were not include, because they values did not match the other internal processes values or were not clear formulated or were to specific for their own case.

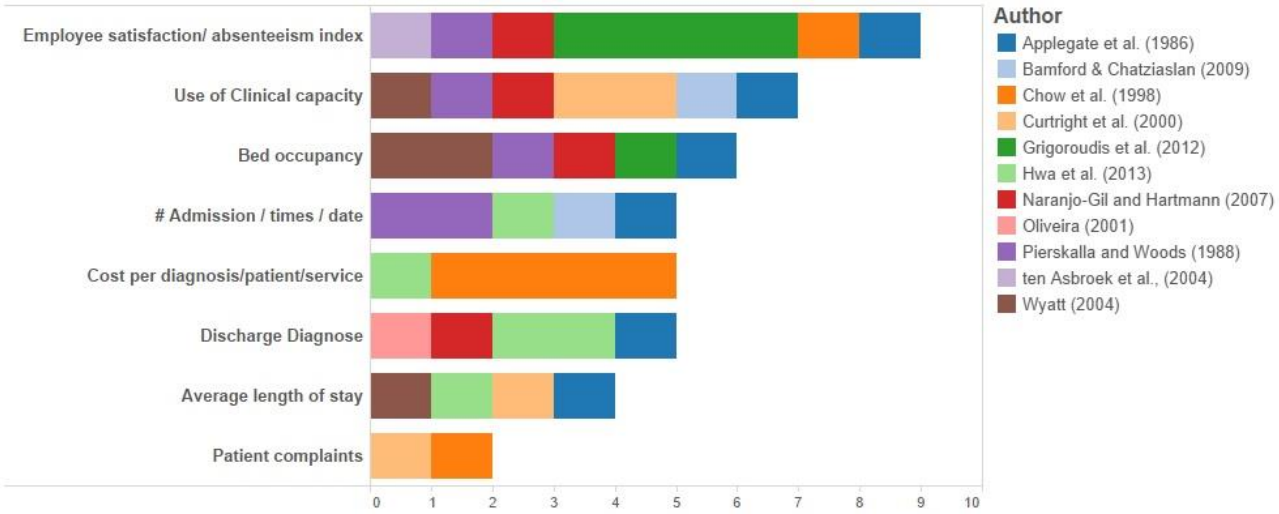


Figure 4 – Ideal KPI's according to the literature

After this evaluation there is a selection of ideal value within the internal process of the Balanced scorecard. Thus could now be an ideal BSC be created, which considers the past research about the KPI's.

First the selection of the perspectives are discussed. Most of the researchers kept the financial perspective within their adjusted or not adjusted version of the BSC. Therefore in the ideal version according to literature this should be included. The next is the customer perspective. Those was often also referred as patient perspective or patient focused. In the scenario has a hospital patients and is the relationship different than in other organisation Yet it is still an service which they are providing. The internal process is refereed as an Clinical utilization (Pink et al. (2001)), Quality of Care (Lorden, Coustasse, & Singh, 2008), Staff perspective (Peters et al., 2007) Clinical focus (Türkeli & Erçek,2010) or in the most mentioned articles as Internal process. The meaning of the perspectives of internal process are different, were the quality of care refers to only the medical aspect, the staff perspective refers to only the employees. In the aspect of internal process those information are both relevant to monitor the internal processes. The last perspective is the Learning and Growth. Best people, Human resources it was labelled but most commonly it was changed to Innovation.

Thus the logical selection was, Finance, Patient focus, Internal process and the innovation perspective. The ideal BSC and the ideal identified indicators can be seen below. The indicators which were compared for the internal process are eight different values. Curtright et al. (2000) Chow et al. (1998) both included the values about the patient satisfaction in the internal process. It seems logical to include that in the patient satisfaction perspective instead. The internal process can have influences of the satisfaction, yet it is hard to monitor.

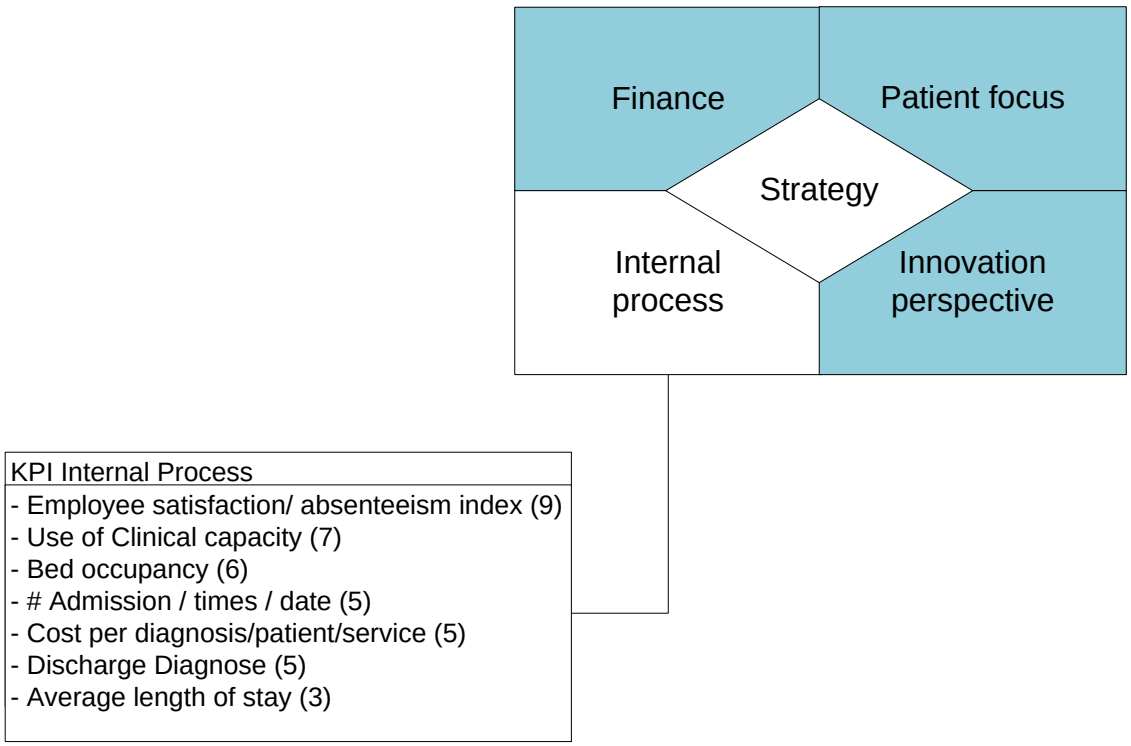


Figure 5 – Ideal BSC and ideal Internal Process KPI's

Grigoroudis et al. (2012) has for the indicator bed occupancy a target for 0.642 of the available beds. Furthermore have Oliveira (2001) and Hwa et al. (2013) some guidelines defined, where Oliveira (2001) emphasised the relationships of drivers and outcomes and the effects on each other. And Hwa et al. (2013) present their own targets, without the description how there are determinate. Yet they emphasise the importance of yearly comparison and trend analysis. The rest if they defined the importance of target described the importance of qualified individuals, committees or head of departments to define realistic target based on historical or experienced information.

Therefore the indicators can get valuable targets in two ways. The first is historical information and the context information from staff and management about those information. Those goals or target give the information that the management has to act on them. Because their developing in poor or excellent way. In both situation a management should be informed, why those values develop.

3. Design & Development: Design Construct & Testable construct

This part is described by Pfeffers et al. (2007) as the part where the artefact is designed. There is a distinction between the desired artefact and the actual artefact . The actual artefact in this case is the prototype and the real-world setting of the desired artefact.

In this chapter the design and development step is described. First Radboudumc is described to define their strategy. Then the design construct is developed based on the Radboudumc strategy. The development and the completed design construct will be described and illustrated.

3.1. Radboudumc

Radboudumc is an academic hospital in the Netherlands. The hospital has about 28 specialisms which have their own department. It is one of the seven academic Hospitals in the Netherlands it works closely together with the University of Nijmegen Radboudumc. It is a non-profit organisation which is managed by the board of directors. The board of directors has five members. The focus of Radboudumc is Patientcare, Education and research which is similar to other academic hospitals in the Netherland.

The academic hospital Radboudumc has four pillars which are implemented/established to achieve their strategy. The strategy is “to have a significant impact on healthcare”("Radboudumc," 2015)

The four pillars are:

1. Excellent of Quality
2. Participatory and Personalized Healthcare
3. Operational Excellence
4. Sustainable networks

The first pillar excellent quality focuses on the research programs, the excellent patient care and to continuously improving and this standard. Participatory and Personalized Healthcare is the second pillar it focuses to find the right treatment for each patient. This means that the patient is involved in the decision making about their own healthcare route. Also they have introduced personalized healthcare to the curriculum of the medical education. The third pillar the operational Excellence focuses on that the healthcare is excellent and will be continuously improved. And also that research and education have an excellent standard. Also that the organisation will be organised smarter throughout the entire process chain. The last pillar is sustainable networks which focuses on regional and international networks for research. This knowledge is applied for education and patient care.

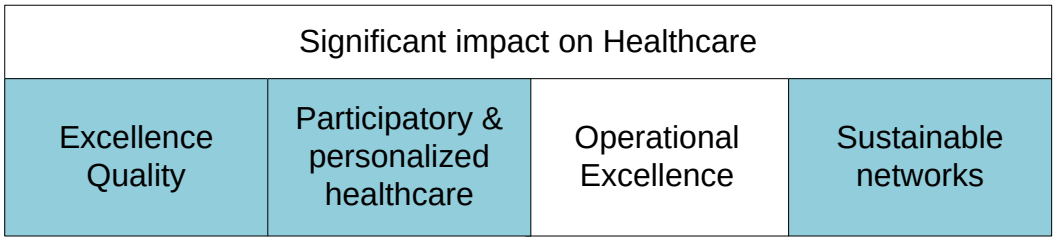


Figure 6 – Strategy of the Radboudumc

This research focus on the topic of the Operational Excellence. Every year each department and also the board of directors formulate a “one page strategy” for the year and the actions which should support the strategy. The strategic objectives on how to achieve operational excellences are:

- We have a clear vision and profile for the patient care
- We have our business process efficient and effective equipped and also make optimal usage of the information technology systems.

The strategic actions on how to achieve operational excellences are:

- Perform efficiency projects to generate a structural cost reduction (about 7 millions).
- Evaluate and redesign the internal financial model and consider the possibilities of clinical pathways and thematise the care chains.
- Give supervisors the responsibilities for operational process that they can give support to departments to optimize their processes

3.1.1. The organisational configuration of the Radboudumc

To describe the communication of the Radboudumc the Five parts of the an organisation model from Mintzberg described from Daft (2010) is used. For this research the technical support and the administrative support is not relevant. Important are the technical core, the middle management and the top management.

In the Radboudumc the technical core are the doctors and the medical staff. They add in their daily service the value to the process. In their daily processed they need the operational information about patients and their tasks. The next part of the organisation is the middle management. This are the head of the departments and the business managers. They are responsible to manage the departments. In their daily task they need tactical information about the department.

The top management needs strategic information to operate and manage the organisation. The information is related to the strategy and the mission and the vision of the organisation.

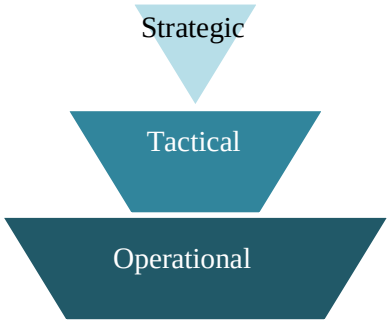


Figure 7 – The information structure of the Radboudumc

This model can be made specific for this research. The focus of this research is the strategy, were the information need is defined. Here the strategic objections and actions are defined and communicate to the company. Then the tactical level defines those in their own actions, which results in the information for the strategic level. At the informational level their register the data, which provides the basis data which can be generated to information for the management information system.

This gives information about the question: *“What strategic insights is needed and useful for the board of directors?”* On the aspect of the one paper strategy of the Radboudumc, there is no measurable

information about the operational excellence. Only that they need to reduce costs and that the processes should be optimized. To measure optimization there is a baseline needed to compare.. In the current situation there is none. The term optimisation is within the Radboudumc acknowledges as a continuous term. This means that improvement and optimisation is not an achieved status it is a continuous process. Therefore the departments aim to perform better than the year before. The comparisons with the last year values gives an indication if there is a change. Dependent of the value an increase or decrease is wishful.

3.2. Design Construct

The Design Construct is designed on the existing theories about management information, strategic alignment. In the S.T.R.O.B.E test the alignment of the Radboudumc was accessed. It was concluded that the alignment is well enough established to use the BSC as a management tool to develop a management information system. To develop the BSC for the Radboudumc the rules and techniques of Kaplan and Norton (1996) are used. In the Literature study other hospitals or groups were discussed, there limitations and results will be used to improve the development of this BSC.

3.2.1. BSC Radboudumc

As earlier described the BSC is developed to translate the strategy to a balanced model to monitor important values. The strategy as described in chapter 3 in the part 3.5 Radboudumc is focused on 4 subcategories to achieve the strategies. These subcategories are similar to the BSC perspectives.

The subcategory: “Operational Excellence” is within Radboudumc similar defined as the internal processes of Kaplan & Norton. This research will only focus on that perspective of the BSC.

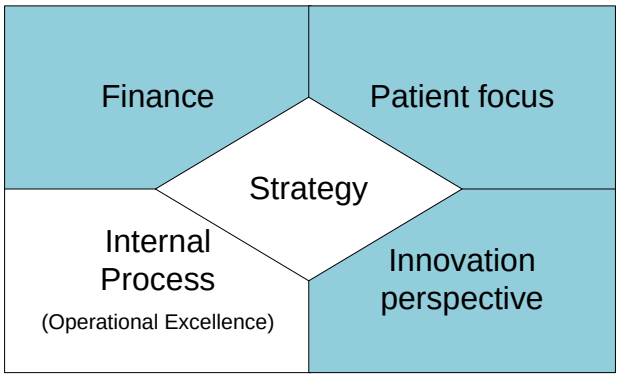


Figure 8 – BSC Radboudumc

In the development there will be indicators which will overlap with other perspectives. The purpose behind that is to try to keep the Radboudumc version of the BSC still in balance. Intentionally this is achieved to develop al four perspectives, but it is chosen to not develop the whole version due to time and data limitations.

It is important to notice that the effect and cause relationship of the performance drivers and outcomes is an important way of seeing the relationship of the indicators.(Kaplan & Norton 1996) Therefore the outcomes are really important values for the hospital. At the moment that the outcomes have not the intended or desired results the performance drivers needed to be changed or adjusted to gain the desired outcome. Therefore is it important to monitor the performance drivers as well.

Thus from the theory of the BSC the following requirements are selected:

- Performance Drivers of the Internal Process
- Outcomes of the Internal Process
- Involvement of leadership (selection of person for validation)
- Transparency of this project (communications and data usage)

The focus on this research is on the Internal process. It is possible that the indicators could have relationships with other perspectives. Chow et al. (1998) had also made the observation that one measurement can have multiple goals.

3.2.2. Development of the Design Construct

This part describes the development of the Design Construct in two phases. The first phase is the outlining of the primary process of the patientcare.

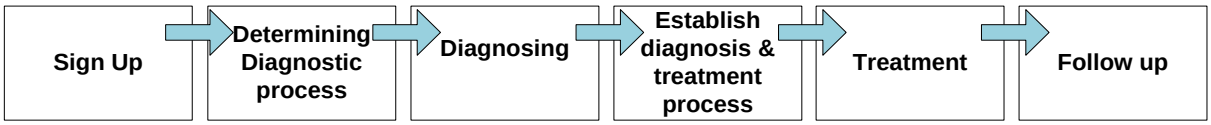


Figure 9 – Simplified model of the patients pathway by B. van Acker (2015)

The first step is the "sign up" where the patient enters the hospital for his/her own care pathway. It should be noted that this pathway is highly complex and different for each patient. This model is highly simplified. The next step will be the determining diagnostic process, here the pathway for the selection of which diagnosing procedures should be chosen. The second step will be most likely the firs visit. Yet again there are situation or options where this is different. Then the Diagnosing will carried out. After the process is chosen it can lead to establish another diagnosis process but will result in establishing the treatment process. If the treatment process is chosen the treatment will start. After this is completed there will be a follow up meeting in most cases. This is for the aftercare.

This Process can be different for each patient. In this situation the information about the capacity of the business processes are relevant. Therefore the input, transformation and the output of this simplified patient pathway will be broken down in parts which should be monitored. Also it is known that the patient will be in the visits to the hospital at least in one of the following "process steps": Outpatient Clinic, OR, Clinic or in the laboratory.

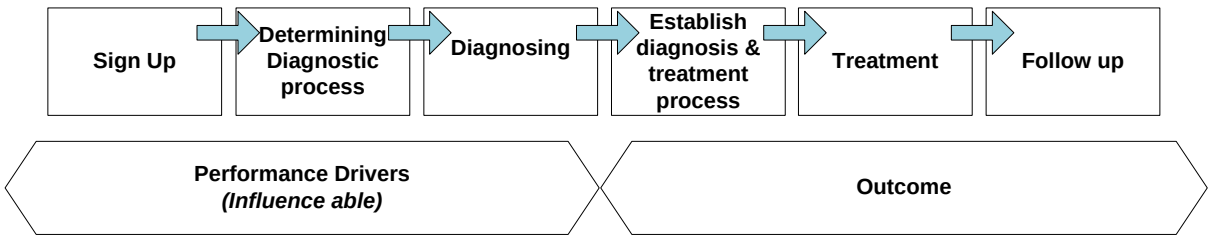


Figure 10 – Step 1 Patient care process

In the Figure 10 the primary process is linked on the theory of Kaplan and Norton (1996) about the theory of performance drivers and the outcome of the process steps at the Radboudumc.

The above the original version of primary process of patientcare can be seen. Below it is spilt in the performance drivers and the outcome. The outcome are the information's, which are available after

the process to place. The performance drivers are the values which can be influenced to change the outcome. The idea is that with the performance drivers the outcome can be influenced. In this case it is the availability of the resources of the hospital. This means the materials, rooms, beds and the staff of the hospital. Yet here it is not only relevant if there are available but also that these resources are well scheduled and organized.

Input	Transformation						Output
Performance Drivers			Outcome				
Patients	Relationship Hospital (Sup)departments	Planning of resources	Volume	Capacity realised	Short-comings	Measure & Improve	Treated Patients

Figure 11 – Design Construct model step 2

After the need of information can be divided in performance drivers and outcome it is further split in elements which give information's about the process. Here we have input, transformation and the output of the processes. The overview of this structure can be found in the Figure 9.

The input value are patients or people which will become patients. This value could be assessed in a more complex way, but then it would consider too much information about the quality of care and for which treatment or specialism patients visit the Radboudumc.

One of the performance driver which is related to the transformation is the Relationship of Hospitals departments. This means the relationship between the outpatient clinic, the operation room and the clinic. It is possible that a patient only visits one of those (sup) Departments. Commonly a patient will first visit the Outpatient Clinic before a OR is scheduled. After an OR it is also common that a patient will have to stay in the clinic.

The final performance driver of the transformation step would be the planning of resources. This is earlier described as the material, rooms, beds and the staff. The planning has the most impact on the realised process, because it defines all available resources.

The following transformation steps are outcome related. Because they described which values are realised. This is information about things which have happened in the past.

These are the volume, or amount of patient, ORs, visits et cetera. The capacity time, thus the durations of the amount. The next value is the capacity realised, this is a value which links the performance driver "planning of resources" to the outcome values. The next are the shortcomings, thus things or situation which should not happened. This can be shortcomings which are internally caused or externally. For example patients who cancel OR's or doctors. The final value of the transformation is measure and improve. This are the comparison of the recent values with historical values, to find trends or extreme fluctuations.

The Design construct gives partly the answer to the sub question. "*How to identify the strategy which is related to the efficiency of business capacity?"*. Yet the measures need to be defined. Those can be found in the next chapter of the testable construct.

3.3. Testable Construct

In this chapter there were measurements developed with the business case owner and the mentor of this project. Therefore first there were interviews hold with an department head and a unit manager. Then a brainstorm session was hold to construct a Fishbone model, to identify the cause and effect within the primary health care process. These added information were used to develop the indicators for the model.

3.3.1. Fishbone Radboudumc

After the Design Construct is created the measures are included. For this approach the a brainstorm session and the method of the Ishikawa Fishbone model was used. This session was held with the same people as the S.T.R.O.B.E test, which are the Senior advisor the PVI Consultant. The session took place on the 24th of June 2015.

The approach of the Ishikawa Fishbone is to find the relation between the cause and effect. This was hold in an brainstorm session, where each input was allowed. The reason for this was to find values and information which is are not already included in their monitoring process.

Outcomes where that the interrelation between Outpatient, OR, Clinic and Clinic are relevant for the overview of the process. Because the patient usually visits first the Outpatient before an OR is scheduled. If OR is not a short stay treatment than the patient will be hospitalised and will be staying in the Clinic.

This is an interesting development, because before they were always monitored and reported as independent entities. It was also in the scope of this research to monitor for each of those process steps.

Another outcome was the importance of the OR. The Outpatient Clinic has effect on how much OR can be scheduled. Despite of that if the OR is completely booked it can lead to delays or a long waiting list for patients. And after all the schedule of the OR leads to the patients in the Clinic.

3.3.2. Development of the Testable Construct

In the next phase the information and outcomes of the fishbone diagram are used to develop the testable construct. It is based on the design construct of the process of the primary process patient care. Here are the values used for to develop measurements for the Outpatient Clinic, Laboratory, OR the Clinic and the Emergencies of the Hospital.

Performance Drivers			Outcome			
Departments	**Relationships**	**Planning**	**Volume**	**Capacity realised**	**Shortcomings**	**Measure & Improve**
Outpatient Clinic	% of Outpatient Clinic/ Labatory/ OR / Clinic will got to another of those mentioned	1) Availability Beds / OR/ Staff 2) Reserved Beds/ OR/Staff (emergency) 3) Scheduled Beds/ OR/ Staff	1) # patients/ visits/ operations / beds 2) cumulative/ total patients/ visits/ operations 3) time per visits/ operations	1) % number of patients/visits/ OR to other years% 2)% Realised to planned 3)hours per Staff 4)Number of patient/ visits/ OR per staff	1) Cancellation/no shows 2) Delay /Longer than planned 4) Not realised to other years	1) Long term analysis of fluctuation 2) Benchmark internal / external
OR						
Clinic						

Figure 12 – Testable Construct

The first square is the relationships, which describes the percentage of patients which comes from one of the departments. This is information which is gathered within the hospital. Yet as described in 0 Radboudumc organogram the departments of Radboudumc are independent organized, which means that they do not have to share this sort of information. Nevertheless is that vigorous information which can be used for the planning. Also in the complete patientcare pathways is in the end interdependent. The planning is the second square, it is important to know which resources are available and which are scheduled for usage and which are reserved for emergency. This information has an impact on the following outcomes. Only the resources which are available and recognized as available (scheduled) can be used. It is also important that there are resources reserved for emergencies. In each and every situation the hospital had to have the capacity to react for those cases. And also after the emergency is dealt with the common activities have to be picked up again and that can mean that more staff is needed.

The next level is the volume of the process. This is the amount of patients, beds, visits or OR's that have been achieved/ completed. The cumulative value is relevant to compare to the years before. It is relevant if the number are the same, because a similar production to the year before is agreed on with the health insurance companies. Unfortunately this is complex procedure and it is deeply involved with the quality of care and the financing systems.

The purpose of this research is to give relevant insight information about the volume and the capacity of the operational process. There are two sorts of capacity. One is the comparison over time. Capacity overtime is the comparison of the capacity to other years in percentage. This value gives the insight if the capacity is extremely lower or higher than in the year before. The other years can be the average of more than one year to have a long term insight in the development of the value. Also it could be used to plan better for the future. This can give the answer if the capacity was used in the same efficiency than last year (or the last three years, this is depending on the amount of historical data) This is built on the assumption that there was no change in the capacity of the department. Another is the planned capacity to the realised capacity. Here can the percentage of the realised capacity to the planned give an insight if the full amount was used. Another indication could be the available capacity to the realised capacity. The last version is to not consider all capacity only the staff capacity. In this comparison hours or the number of visits, patients, OR's per staff could be compared. This value can be compared between years, but it could be compared with department which are similar or have similar amount of staff.

The Errors of the process, can also give an insight if the process runs/ functions like it should. An Error of the process are cancellations of visits or OR's. If the planned amount is not reached, could this be because the planning was not good. Also delays or if the patients stays longer than it was planned are indicators that the planning should be improved.

The last indicators are the Measure & Improve values here are three measurements identified. Here could be the long term analysis of fluctuations. High Fluctuations in a process can disturb the whole amount of capacity. For example if the department has at one point 30 patients in 30 beds and the rest of the year only 15 beds are used than the department has to deal with a high fluctuation (B. van Akker, personal communication, July 20, 2015). In this example the rest of the time the department has 15 unused beds which are about 50% of their available capacity. It would be relevant to reduce the amount of beds to achieve a higher usage of the available capacity. Yet it should also be found a solution if they need the 30 beds.

Also in long term data collection the goals of department in what they desire could be generated to internal and external benchmarks.

In the consideration of each phase, process step there are 48 indicators developed to give insight in the process capacity. This give the complete answer to the question "*How to identify the strategy which is related to the efficiency of business capacity?"* . These list of indicators can be found in the Appendix D.

3.3.3. Validation of the testable Construct

In this part the testable construct is validated with the available indicators of the data model of the Radboudumc. In the next part the indicators which were discussed in the interviews are described.

3.3.4. Ideal vs. available indicators

The ideal list can be found in the Appendix D. The availability is checked with an Information Analyst of the department BI&A who can access the data and helped to build the current version of the data model. Also another system where the personals data is stored was discussed by a PVI consultant who is specialised to develop analysis and reports based on that system. (Information Analyst, personal communication, June 18, 2015) (Consultant, personal communication, June 30, 2015)

There are 22 values available via the data model and 20 are not available and 6 of them are in development. Therefore only the 22 values can be used in the prototype.

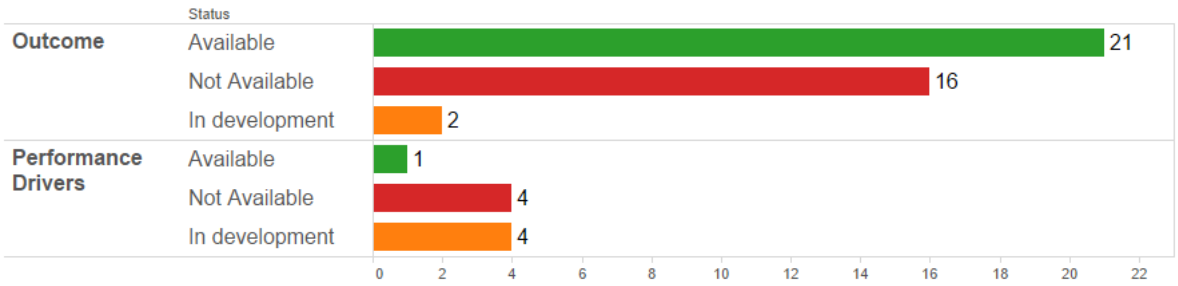


Figure 13 – Outcome and Performance Drivers available

In the Figure 10 the available indicators of the outcome and the performance drivers are shown. Most of the outcome values are available, but there are 18 values not accusable for the development of the prototype. The Performance Drivers are mostly not available or in development. There is only one value available which is the scheduled OR time. Interesting is that the one performance driver value which is available is in development for the outpatient clinic but not for the Clinic. There are outcome values which are based on a performance drivers, those cannot be used for the Outpatient Clinic or Clinic.

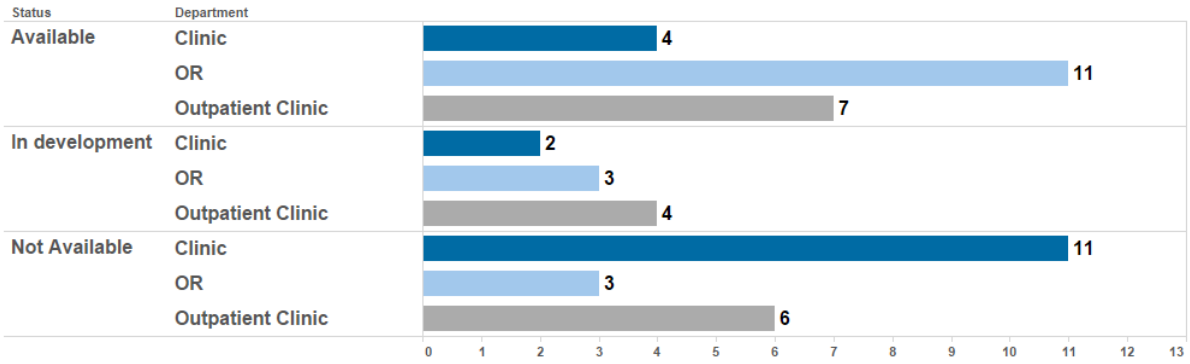


Figure 14 – Available indicators in Clinic, OR and Outpatient Clinic

It was noticeable that the OR is the only department which has a performance drivers. This results logically also in one more available outcome measure "realised to planned". The current data model is more set up regarding OR data than of the other departments. The outpatient clinic has the most indicators which are in development. This value is closely followed by the other departments.

It is certainly right to conclude that the most not available indicators are for the clinic. This is only logical because for each department there were 16 values developed.

Apparently the performance drivers are not established in the current data model except of one value. This will inhibit the development of the prototype and therefore the ideal version cannot be completely be validated. Also the values are per department unbalanced integrated in the data model. Especially the difference between the values of the clinic and the OR.

Also the performance drivers are needed to have a insight in the realised capacity. It is hard to put the volume and realised indicators in context as the planned value is not known. The planned capacity is the value of the available resources if those are not known it cannot be concluded if those are used in an efficient way.

3.3.5. Available vs. former indicators

The next step of the analysis considers how many information of the ideal and available indicators are currently used in the reporting system of the Radboudumc. It should be noted that the current system is only available for the tactical level. This means that the reports are built for each department. It can be accessed that the values can be seen for the whole Radboudumc. This means one aggregated value for all departments. Departments cannot be compared or viewed at the same moment. It is a static numeric report.

In the current report are 12 indicators used of the ideal and 37 are not used in the report. Of the 12 which are used. They have 21 indications, which are different split because of financial and health care aspect. Those were aspects were not acknowledged in the development of this ideal indicators. The table about the former indicators can be found in Appendix E.

Here is noticeable that the OR has the most used variables, which explained the setup of the data model. In the earlier brainstorm it was also shown that the OR values are important in the whole process. Therefore it is consistent that the values are more established.

The last sub question was: *"Can collected hospital data give enough insight in the efficiency of the business capacity?"* In this case study is was difficult to access the operational business capacity and

volume, because of the arrangement of the data model and the registration of information. At this moment the collected data cannot give enough information in a strategic information about the efficiency of the operational business capacity and volume. This is because the available capacity is not represented in the data model for each value, therefore the realised capacity cannot be presented. The available capacity at this moment can be only presented for the OR process.

3.3.6. Validation of the indicators

The testable construct is developed on the basis of the patient care process within the Radboudumc. This therefore makes the linkages between the realised strategy and the indented strategy. The formulated strategy action concerning the business capacity was "Give supervisors the responsibilities for operational process that they can give support to departments to optimize their processes" and "Perform efficiency projects to generate a structural cost reduction"

The indicators within the testable construct are then evaluated concerning the literature about the BSC. In that aspect not all literature was searched for KPI's but only the ones which were selected in the literature method. Most of the indicators can be found in the literature, some of them are broader formulated or different. Yet there were six indicators of the 17 developed could not be found in the literature or was not formulated specific enough. Therefore it was labelled as "not found".

After that evaluation the testable construct was presented to the interviewees. This was presented in the model way on paper and the presentation with the hospital data within the prototype. The experts added nine indicators which were not in the developed testable construct. Also they mentioned 17 indicators which are in the testable construct, that they experienced as important.

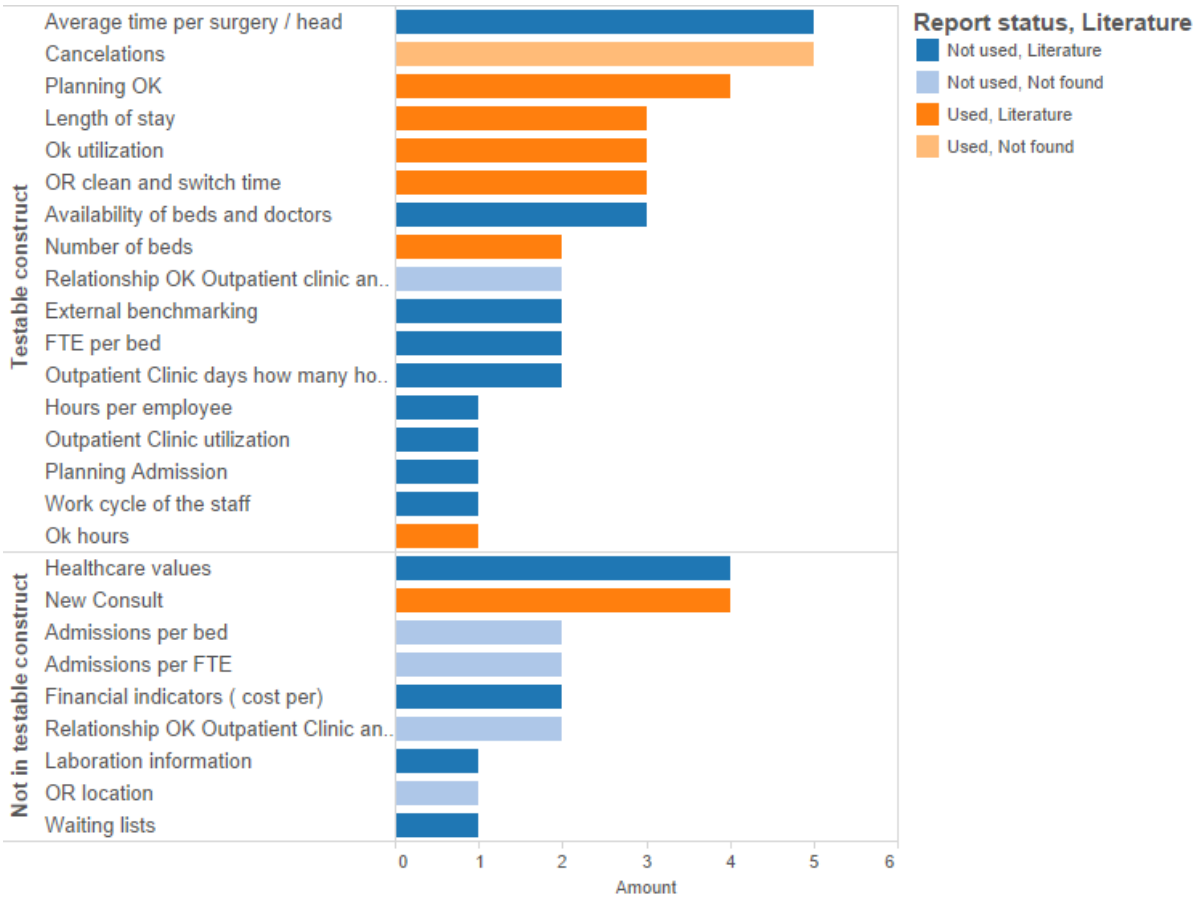


Figure 15 – Indicators from the Interviewees

There were 26 indicators mentioned of those were nine not included in the testable construct. All values within the testable construct were mentioned. Therefore the testable construct is consistent with the need for information. Interesting is the diversity of the need for information, the interviews were conducted with eleven different persons, and none of the indicators is mentioned eleven of ten times. The maximus of the values which are mentioned is five times. All of them agreed on the need for information about planning, yet they had their focus on different aspects of planning. This can be explained with the fact that each interviewee had a different function in the company and therefore their work focus is differentiated.

The mentioned indicators by the interviewees are eight included in the recent report of the business capacity and volume. And one of them was not include in the testable construct, because it was then not considered a value which as influence on the process. It was considered a financial indicator. (Yet is was stated that a new consult should take more time) The other ten are values which are not included in the report, but where important to the experts and also in the testable construct. One values was included in the testable construct which could not be found in the literature, this was developed during the phase of the fishbone diagram of the Radboudumc.

In their current report they have 7 of them their already had in their report and valued them as important. Yet the other 10 were indicators they do not have in their standard report. In the interviews it was revealed that there were many not standardised report which were built or created in Excel to gather the information. The interviewees had defined the problem that they lacking information and created own report. Those values were included in the testable construct. Also their mentioned nine values which are not in the testable construct and four of them were also not found in the literature.

There are nine values not included in the testable construct. The first three values like admissions per bed, admissions per FTE and the relationship of the sup departments OR, Outpatient Clinic and Clinic are valuable information about process information and the staff location. The admissions per bed and FTE give information how the admissions are related to the beds and staff and if those resources are used wisely. The Planning information about the relationship of OR, Outpatient Clinic and Clinic gives insight the patient flow is planned. This information can give insight how those procedures could be improved. The waiting list of patient could give here as well valuable insights, but this would be a value which concerns more the patient perspective. The information about the OR location and the laboratories, were considered to be more operational values and have less interest for the strategic insights. The last three of those values are concerned with values about healthcare or financial values, which were exclude for this research. Those are valuable information for the further development of this model for the three other perspectives.

There were a lot concerns also considering the presentation or the visualisation of the values. This could be because they were used to a presenting the information in tables and numbers. In that case the tool Tableau was a valuable, because in that environment the visualisation could be easy changed to the desired visualisation.

The concluding remark about the testable construct is that it identified the need about information for the Radboudumc. Yet there are important values missing. The strategy action lies on cost, financial values are not included in the testable construct. The decision to not include financial values were that for example “cost per action or patient” are more an indicator for the financial perspective. The second strategy action want to optimize the process. This action is further not specified or made into measures. The testable construct delivers values to monitor the process and also accentuated the importance of gathering information about time to create internal benchmarks.

To answers this within the validation criteria's of Wieringa (2009) the problem oriented question are answered. The insight about the perception of the interviewees was used to create the prototype and also used to develop the testable construct. Within the trade-off question the suggestion were about different indicators or other visualisation of the indicators. In none of those scenarios they reject the presentation of the monitoring of the values. Therefore it is concluded that E satisfy stakeholder criteria C. This is because this presentation of the indicators within the prototype could be a solution to satisfy criteria C. Were C is the strategic insight in the operational business capacity.

4. Demonstration: Prototype

In this chapter the development of the prototype is described. For the development the hospital data will be used. First it will be accessed how much of the ideal indicators are available in the current data model of the Radboudumc. Here should be noted that the data of the EHR is not taken into consideration, because this cannot be done due to time limitations.

The prototype is the demonstration of the desired artefact (Pfeffers et al.,2007) and thus the actual artefact, which test the availability and transformation of the testable construct in a real world setting.

4.1.1. Data source used for the prototype (available data)

The Radboudumc has the department BIA which is responsible for the support and maintenance of the data models, data storage and reports. The data used in the models and reports are from the EHM and other support registration systems. Information is needed to trace the healthcare path of the patient to trace the DBC or DOT's for the financial administration. They also have systems to guarantee the quality of care and information systems about that. They use the new EHM system about 2,5 year now. Therefore there is only data about 1,5 years available for the topic of business capacity and volume.

At the time of the development of the prototype they are in the progress of developing data models for the business capacity. The data model for the business capacity is based on the data from the EHM. The reason that the business capacity is not yet completely accessible is because the data about financial information or quality of care information had more priority.

They also built cube (it is a multi-dimensional generalization of data) which the business managers are using to create their own repots. In the usage of the operational room, a lot of the information is standardised. In the current situation the data entry is not validated therefore it is possible that data contents wrong information. The EHM is designed to give the information the operational layer needed. This means report or in system dashboards.In the chapter ideal vs. available indicators the information is given which values are included within the data model.

4.1.2. Tool selection for the development phase

In this phase a tool selection was approach. The selection phase is not done in a comprehensive study. The requirement for the tool are presented below. There are sorted by importance, which means the first has the most importance.

Table 4 – Tool Selection for the prototype

Requirements	Microsoft Excel	Business Objects Web Analytics	Tableau Software
Free or already purchased by the Radboudumc	Purchased	Purchased	Free license for students
Easy assessable / changeable	Yes	No	Yes
Access of large data set	No	Yes	Yes
Diversity / multiple data sources	Yes	Yes	Yes
Ad hoc analysis	Yes	No	Yes
Interaction in the tool	No	Complex	Yes
Visualisation	Yes	Yes	Yes

The first tools are Microsoft Excel and Business Objects Web Analytics are in use of the Radboudumc. Therefore they were considered in the selection. The next considered tool is Tableau Software. This is because the researcher worked earlier with this tool. It is clear that the tool Tableau fulfils all requirements. Yet the requirements are defined for this research. For an implementation those requirements would need more specification for the organisation.

In this selection it can be concluded that the tool Tableau has some clear advantages against the other tools in the usage. It combines strength the tools purchased by Radboudumc. Tableau has the easy accessibility like Microsoft Excel. Tableau can also access large data set as Business Objects Web Analytics. The strength of the tool Tableau lies in the ad hoc analysis, which is not the focus of the Business Object Web Analytics.

For a fair comparison it should be mentioned, that if the Dashboard should be implemented Radboudumc must purchase a license for the Tableau Software. Therefore is Tableau for this situation ideal, because the prototype can be done for this research.

4.1.2.1. Development phase

The development phase of the prototype uses interviews with experts. This was an iteration process. In the interviewees could mention improvement steps or point out issues with the information. These steps were evaluated and if possible and relevant included in the development of the prototype. The complete list can be found in the Appendix H.

The tool was developed in an adhoc manner with the earlier described tool. Tableau is a visual tool which is easy to learn and to develop dashboards and interactions.

4.1.3. Screenshots final version

In this section the screenshot of the final version are discussed. The complete prototype will not be discussed here. The remaining screenshots can be found in the Appendix K. The main overview which present the business capacity and volume information about the whole hospital and the three main overviews about the OR, outpatient clinic and the clinic will be described below.

4.1.3.1. Main overview

Below the illustration or screen shot of the main overview is shown (the prototype is developed in Dutch, because the users and the data is in Dutch). The first image is about the outpatient clinic. There is a line chart with the cumulative amount about the appointments within the outpatient clinic and below the trend line of the appointments is shown. There are two lines the orange is this year and the blue the year before that. The comparison between was chosen to simulate a reference line. Below the Outpatient image the OR information is shown. The first line is the cumulative amount of the OR sessions . The second line is also the trend line from the OR sessions. And the third line which is the used capacity of the OR. This value was only available for the OR within this hospital. The last information is about the Clinic. It is similar to the outpatient clinic, the cumulative admissions and the trend line of the admissions are shown.

The assumption which can be made concerning the outpatient clinic is, that the trend line and the cumulative amount give the information that the development is steady an similar to last year. The same conclusion can be drawn for the clinic. Only within the OR the used capacity is shown, this value lies above the last year and looks improved. (Yet this information is about all the different specialities) The main overview cannot provides specific information about the operational business capacity and volume. There can only be made assumptions about the information. It is necessary to examine more detailed information to make conclusions.

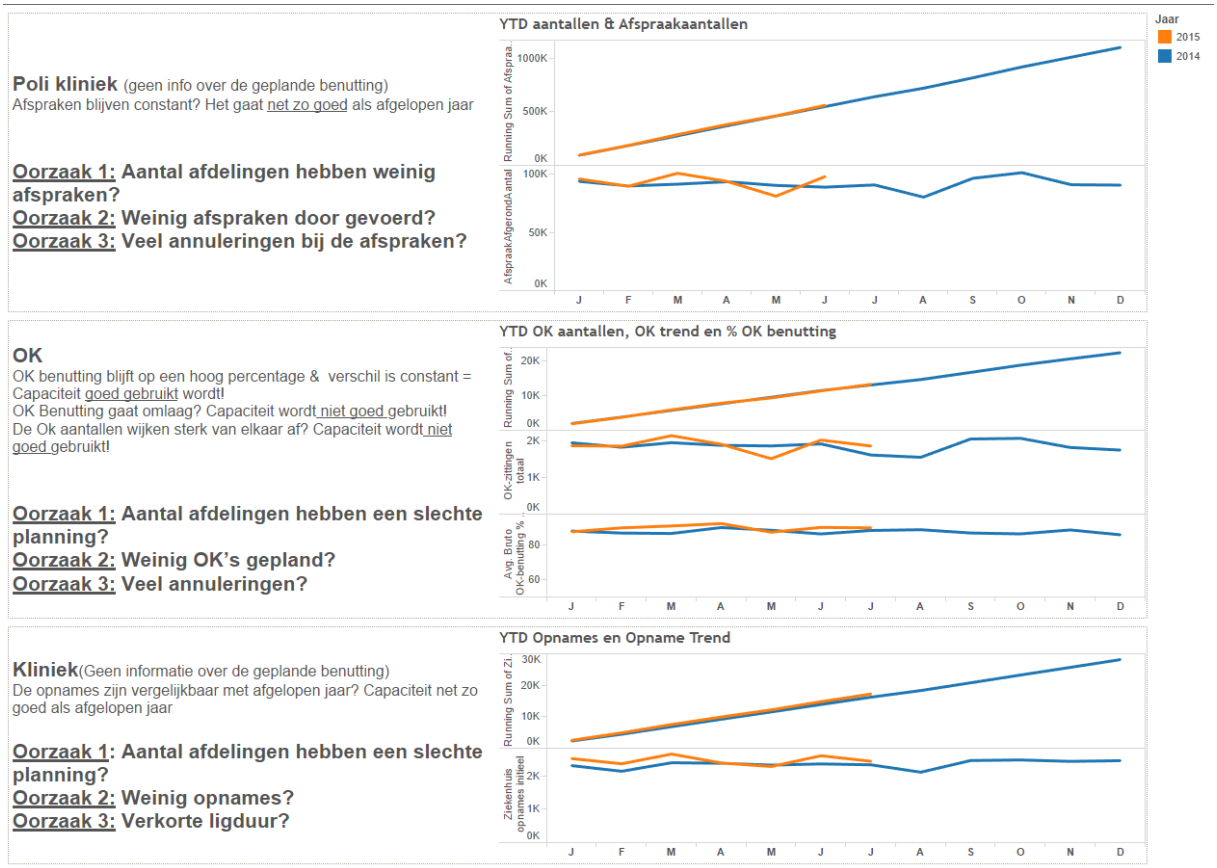


Illustration 1 - Main overview about business capacity and volume

4.1.3.2. Clinic overview

The next image is the overview about the clinic. In the left corner the admissions and the length of stay are shown for each speciality.

The order of the bar charts are, admission, percentage difference of admissions to last year, length of stay and the percentage different of the length of stay to last year. The bar chart shows the bed occupation. The dark blue bars is the average of bed occupation, the red line is the maximum and the grey bar chart is the difference between the maximum and the average. This gives an indication of the fluctuations of the bed usage. An optimal usage would have a low fluctuation. The scatterplot diagram compares the admissions of patients with the length of stay. It is shown that difference between the specialities is high, which is logical due to the differences in treatments and medical patterns of different specialities. The same colour indicates that it is the same specialities, within the same colour there are still extreme differences. To analyse this more specific, more medical information is needed.

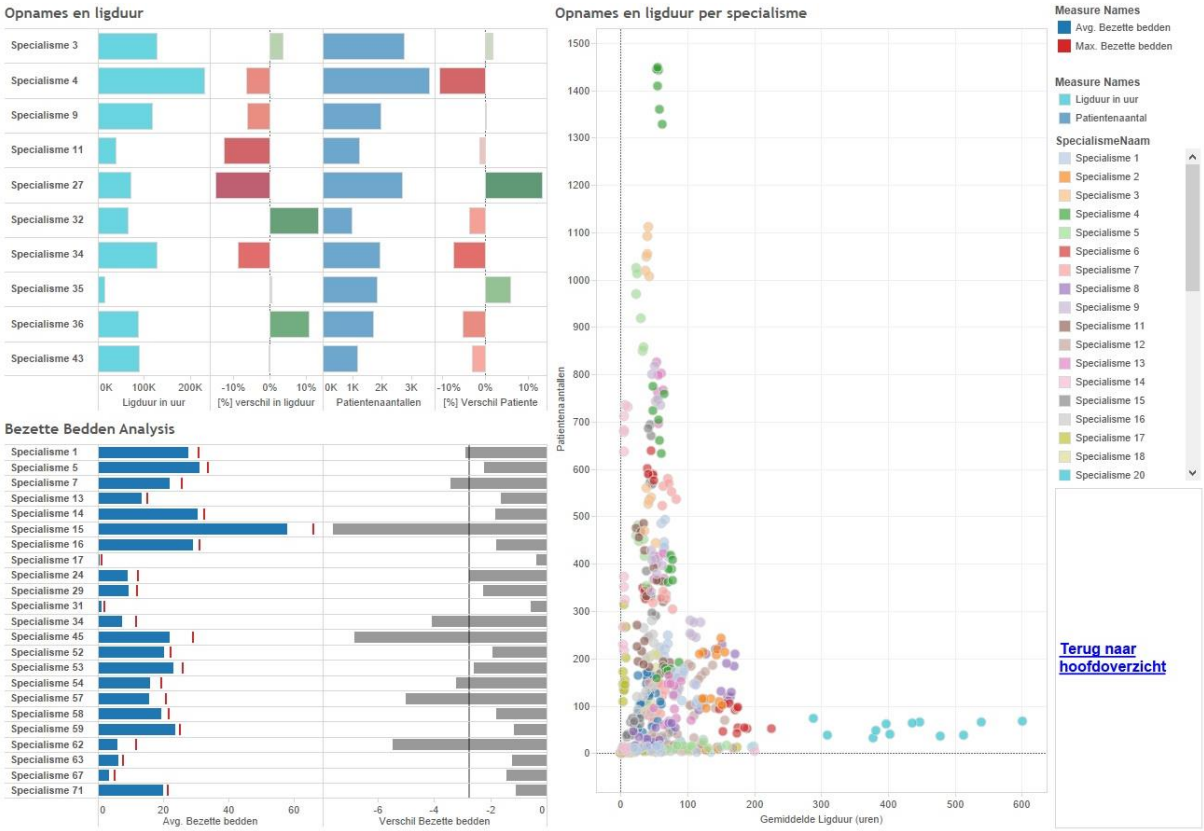


Illustration 2 - Clinic overview

4.1.3.1. Outpatient overview

This screenshot gives insight in the appointment in the Outpatient clinic. In the left image the appointments, the percentage different of appointments to last year, the appointment time, percentage different of appointment duration to last year. In the right corner above the accomplished appointment, the cancel appointments and the no-shows of appointments are shown. And also these are compared to the last year result and presented in a percentage. Below there is a scatter plot of the appointments and the appointment duration.

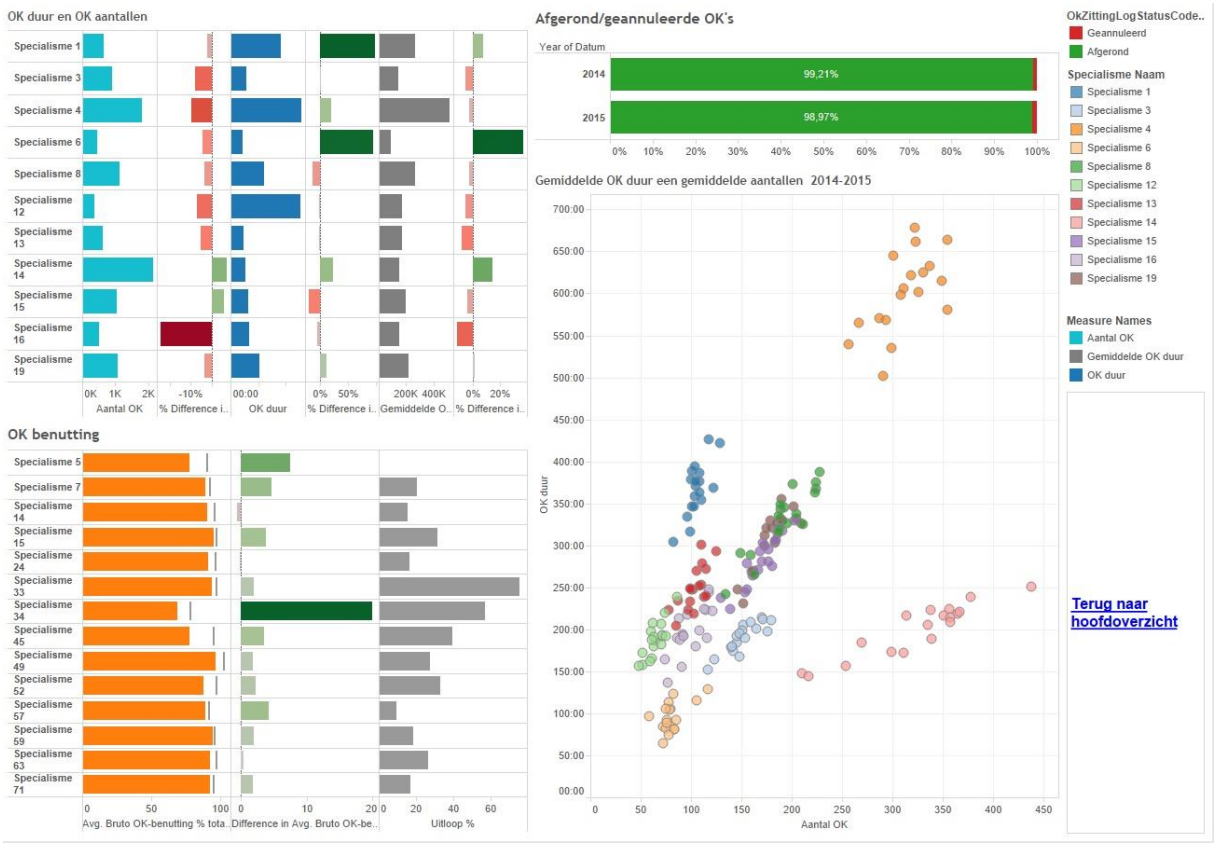
The accomplished appointments seem to develop positively compared to last year. The cancelled and no show appointments are decreasing and the overall amount of appointments is stable. Also the scatterplot show some outliers, but it is quite logical development and no extreme fluctuations are noticeable in the same speciality.

Illustration 3 - Outpatient clinic overview

4.1.3.2. OR overview

OR overview illustration has the same structure than the others above mentioned. The left bar chart above are the information about the OR duration, the percentage different of the OR duration to last year, OR sessions, the percentage difference of the OR sessions to last year, the average OR duration and the percentage difference of the average OR duration to last year.

The bar chart on the bottom right side gives information about the average OR capacity usage per specialism and the maximum OR capacity usage (this should be replaced by an accurate benchmark for that speciality). The right bar chart above shows the cancelled and the accomplished OR's. It is a comparison between this and last year. Also this overview has a scatterplot the y-as is the OR duration and the x-as is the OR sessions. In this graphic most of the specialism are clustered about the same values, only two specialities have extreme outliers within the speciality. This indicates that they have to deal with extreme fluctuations, which would not be desired in an optimal usage of the business capacity.



Those four overviews give insights in the business capacity. These are further developed per category to analyse the cause more specific. In this overview it can be considered that the information is available at the hospital can give insights in the efficiency of the business capacity and volume. Nevertheless the planning values are missing in the outpatient clinic and clinic, which lead only to assumptions about the capacity and cannot give a definitive answer about the efficiency of the usage.

4.1.4. Validations of the prototype

The validation of the prototype was not the concern of this research. Therefore usability and visualisation are not critical assessed. It was mainly used as a tool to present the values and the

testable construct. The prototype should ensure that the experts could relate to the information and to the indicators.

The experts showed an overall positive reaction to the way the indicators are presented. Also feedback concerning the presentation and visualisation of the prototype were included in the final product. This product will be further researched within the context of the hospital and the data will be validated. After those steps the product will be implemented within the hospital.

The indicators were validated and this is described in the previous chapter. Yet the visual aspect of this was important to the user as well. Also the tool was noticed positive because of the easier interactions and the visualisation possibilities.

Further research should be acknowledge the importance to present the values to be easier to understand. This means the usability, the interactions and visualisation should be researched as well.

5. Reliability & Validation

In this part the reliability and validation of the research will be accessed. This should not be confused with the validation of the prototype or the validation of the testable construct.

5.1. Reliability

The reliability is according to Golafshani (2003) is about the repeatability. The repeatability can be biased in this study by six factors. Those are the researcher, the used method, the interviewees, the setting of the interview and the communication or interaction between the interviewees, and the used tool for the prototype.

The main bias in this study is the bias of a single researcher. This could have effect on coding of the information gathered in the interviews and observations. Therefore another researcher could have gathered different information or interpreted differently. Yet it was done by a student which worked at the hospital. Therefore the information were collected from a college, which could have contributed to the degree of in-depth information.

The used literature and method is clearly documented, therefore another researcher should be able to replicate this research with the same method. Thus the literature method, the selection and the discussion and the development approach is described. Nevertheless is the development of the prototype and model based on a creative approach, which is biased by the setting and the researcher.

The interviewees were selected by the researcher and two employees of the Radboudumc on the ground of the speciality and knowledge regarding this topic. There was also used triaging of methods within the gathering of empirical data. Because this topic is quite specific not many people within the company were specialised, that has the reason that there were only a few semi-structured, in-depth interviews. Also the interviewees are working together therefore which could influenced the information that was gathered.

Also this research was started after there were a project group launched for the development of a report for the operational business capacity and volume. This could affect consciousness of the interviews about this topic.

To build the prototype the tool Tableau was used. This gives a lot functionality which is not available in the currently used reporting system of the Radboudumc. Therefore it could have trilling effect on itself. Preventing that effect the interviewees would get the information that it was a mock-up tool and not a representation of the future report system.

Also Golafshani (2003)stated that the reliability is a consequence of the validity in a study. Thus there is an emphasise to improve those is described under the aspect of validity.

5.2. Validation of the Research

This research design used the validation approach of (Wieringa, 2009). He notes that the design science is rather a method with artefacts than facts about nature and concerned with search for111 prescriptive rules for design. The design science approach of validation ask a question about a "thing" that does not exist yet; the implementation. Therefore models or prototypes are used to validate it. Yet if the validation of the models seems unconventional, the research method needs to be validated in a scientific method.

As Golafshani (2003) states, qualitative research seek a more illumination, understanding and extrapolation to similar situations than the quantitative approach. Therefore the validation and reliability approach are also different.

The reliability is a consequence of the validity in a study (Golafshani, 2003). And the perception of a researcher can affect the validity of a researcher. As approach to improve the validity of this research it was chosen for a construct validity approach.

According to (O'Leary-Kelly & Vokurka, 1998) construct validity is the representation of the correspondence between a construct and the operational procedure to measure or manipulate that construct. Also they state that the first step of construct validity is content validity. This is necessary to demonstrate that the empirical indicators are logically and theoretically connected to the construct.

The first step of construct validity is the content validity. This research started with a problem definition and was followed by the objective of the solution. In the problem definition and the literature method the used search words and search methods were defined. After that the literature was gathered concerning the topics, there was a model build based on the BSC card. The balanced scorecard the internal process dimension was built and the ideal version was filled with business capacity and volume terms. This process and approach reassures that the built design construct fits in the theory and the background literature.

Then in the evaluation and validation of the prototype the results are used and compared to the literature outcome to evaluate if it fits in the literature context. This improves the construct validity. Hence are the development of the testable construct and prototype involved a creative process step which limit those comparisons. This is because the prototype is developed to a quite specific issue for an specific environment. Yet the indicators can be compared.

6. Analysis

Evaluation of Pfeffers et al. (2007) describes the observation and measurement of how well the artefact supports a solution to the problem. The desired abstract of this research is the testable construct, which is demonstrated in the prototype. Observation and measurement of the testable construct is done in two steps. The first step is de validation of the data and the second step are the

interviews. In this research the evaluation step is replaced by the validation step. Nevertheless the analysis if the artefact supports the solution is necessary.

In the problem identification and motivation it is summarized that there is a need for strategic insight in the operational business capacity and volume. Objective of the Solution of the research, is the literature study which literature is discussed which target strategic insights, models and measures which contribute to the ideal BSC. In the design & development the gathered information of the literature is applied for the context of the Radboudumc and measures are developed for their need.

The information is gathered for the analysis of the artefact in two phases to test if it provides a solution for the identified problem. In the validation step of the design and testable construct there were not much values mentioned which were not in the literature or not in the testable construct. (Logically because the testable construct is built on the literature) Therefore the design construct contributes to identifying the information which is needed (as defined by the interviewees). Yet due to the lack of data, the prototype includes no planning values (except for the OR), therefore this information could not be validated with real data. The information about planning was one value al eleven interviewees agreed on strongly that it would be an valuable asset for the current report.

Performance drivers are crucial to be related to strategy, because when it is realised what was planned, it can be concluded if the resources were used efficiently. The capacity of the hospital is defined by what they are planned to use. This is due to that there are in a service industry were the service of people add value to the process. In production organisations a machine is 24 hours seven days a week available and humans are not.

To optimise process the values of planned information need to be compared to the realised information. Then it can be seen if the planning is realistic and the resources are used optimal. The optimisation of the process is one of the two strategic goals of this hospital. They identified the information for the OR, in this aspect they compared the planned capacity with the realised. There is a lack of access to the information, this is due to registration, the data model or the limited access to the data. The current report used twelve values of the ideal 37 values. The interviewees agree on that there is insufficient information to evaluate the process. Interesting is that there are already generating own reports with Excel to resolve the lack of information. The testable construct included the values their gather in the excel report in less detail, that those information can be used for the whole hospital.

Most indicators mentioned are included in the testable construct. Only nine were not included, were three values are excluded upfront and the other six are marked less relevant. The three values should be considered in developing the model further for the other three perspectives. One value about the planning of the relationship of OR, Clinic and Outpatient Clinic should be included. The testable construct provides the answers the interviewees identified as necessary.

Interesting is the diversity of the need for information, the interviews were conducted with eleven different persons. This will also create a challenge for the division of the financial, patientcare and healthcare values. The concluding remark about the testable construct is that it identified the need about information for the Radboudumc.

Another concern is if the testable construct can provide the Radboudumc with the strategic insight it needed. The strategy actions lies on cost and optimizing the process. The testable construct cannot give insights in the financial information of the process. It can give insight in the optimizing of the process. If the BSC model would be further developed for the other perspectives the information

about process could be linked to financial information. At this point the strategic action of optimizing the process have no targets, the testable construct can be used to develop those.

Testable construct satisfy the need for information in the aspect of optimizing the process. Further research should target the financial information to related to the other strategic action. This research provides the information how to use the ideal BSC for the internal process information. Yet in the objective of the solution there were information and measures gathered for the whole BSC. In Appendix N the steps how to transform it can be found. This holds it limitations because the perspectives are interdependent from each other and have different focuses.

The prototype presents in in what extent the testable construct can be used in the context of the Radboudumc. The first overview which should provide clear strategic insight, does not provide the information if the capacity and efficiency is good or used optimal. The amount and volume can be only compared over the years. Therefore the prototype included the tactical level, because at this level it can be concluded if the Radboudumc used is resources optimal and efficient.

The contribution of the research is that a method is developed how hospitals can gather the information they need to monitor the efficiency and capacity of the internal process. In this case study there came across three different obstacles:

- Access to the data (because different systems are used)
- Registration of the information (not digital)
- Diversion of need for information

The testable construct is the desired artefact and the prototype is the real world representation of the construct (actual artefact). Data limitation cause that relevant values are lacking and the prototype cannot provide the Radboudumc with strategic insight.

7. Recommendation

The BSC is chosen for this research to develop measures and guide the measures development for the MIS. The question if the BSC is a fit to develop a MIS? MIS has different requirements and can be used by different stakeholder. In this case the stakeholders are at the strategic level. In this scenario the BSC helps to guideline the use of strategic information and transform them to measures.

A important value of the BSC is that it is a balanced system. This is difficult to achieve, but important for a company. Because commonly known is that "you navigate the organisation where your focus lies" Therefore diverse information is needed, to keep every aspect in your company in focus. This is followed by the next challenged, that the report do not has information overload. It seems that people who have too much optioned feel not able to made a profound decision.

This research focuses only on one perspective, therefore cannot give a clear answer about the balance for the whole BSC. In this research the diversion of information need can be seen by a small group of eleven people within the same company about the same topic. Therefore the balance of the BSC is a challenging project, yet in the final situation a prototype was developed which gave broad yet specified information. It was chosen to give the options for detailed information, when it was needed. But present the most relevant information in the first view.

Strategic insights, which values are missing, how could this be improved. Improvement can be measured if there is a comparison between the values. In this situation the comparison between volumes has weak points, about the availability of resources. Yet if you compare the planned available capacity and the realised capacity there are precise information on how they organise their resources and how are they used. In that comparison it can be seen if their optimize the usage. This put the information about volume in a better context to judge the information.

The Radboudumc organisation gives the departments interdependence to organise them as best as possible. To invade the freedom by measures one measure for each department could generate culture problems. One solution would be to use the same measures, but give them the freedom to develop realistic targets for their departments. Those could be developed with the current prototype and more historical data and information about the other perspectives. In the current state the departments are monitored on the quality of care and the financial values. Those values are not combined in the monitoring, also they have as an academic hospital the priority's to give excellent healthcare, excellent education and also excellent research. Therefore the innovation perspective is also a relevant.

In the current BSC there are four perspectives. One question arises where to place the quality of care in the BSC. This is one of the main process besides the education and research of the hospital. In the literature the innovation perspective was interchanged for quality of care or it replaced the internal process. In the researchers opinion it should be a part in each perspective, yet it is mainly interesting in the patient perspective and in the innovation perspective. Then the information about the process of the clinic, the outpatient clinic and the OR are clearly interrelated with the HC. This is operational information about the process. If the healthcare information can be grouped to be viewed in a more strategic and tactical way, than this could be give deeper insight in the process. In the current state this is not possible for each department (medical specialism). In the interviews it was mentioned that a few medical specialism are in the development of those grouping.

8. Discussion and Limitations

This research contributes to the development of the BSC within healthcare and the development of KPI's. Even so it has limitations like that is this is developed by one researcher or within a case study setting. Those limitations are described within the reliability and validity of the research. In this section the limitations about the research and its contribution to further research are discussed.

The research does not take into account that a management support system could improve decision making like Forgionne and Kohli (1996) stated. This could be further researched by considered which actions of the strategy are more concerned or more realised.

Also Andersson et al. (2004) were concerned that the administrative, financial and clinical systems are not ideal designed to gather the needed information. This is partly analysed in the section about the data model. Nevertheless should this be further accessed and a design for an optimal configuration of the systems should be researched.

In the testable construct the external benchmarks are mentioned, yet there are not distinct defined. The importance of the external information was acknowledged by Curtright et al. (2000), who stated that external information is necessary to manage a hospital.

This research helps to trace information about the actions and their relationship with the strategy. It does not give a clear translation from the strategy to action like Grigoroudis et al. (2012) proposed a BSC should give. This is because the complete BSC is not formulated and developed, only partly information about the strategy is available in this design.

The development of the testable does not include the four values from the literature. Those are the Employee satisfaction/ absenteeism index, Cost per diagnosis/patient/service, Discharge Diagnose, patient complaints. Those values were considered as values for a different perspective or not directly related to the process.

Eventually this prototype will be implemented, there are no guidelines mentioned which support the management transparency and the leadership support. This are valuable information which could other ways let the implementation fail like in the case of Lorde et al. (2008)

9. Conclusion

The research question is: "How can collected hospital data be used to give the board of directors strategic insight in the efficiency of the operational business capacity and volume of the academic hospital Radboudumc?" This question has an explorative approach. In this research the possibility of a management information system with hospital data is explored with a prototype. This is structured according to the testable construct and this can give strategic insight in the efficiency of the operational business capacity and volume.

Nevertheless, for the Radboudumc this current prototype cannot provide strategic insight in the efficiency of the operational business capacity and volume. This is due to the lack of data and that the current strategic goals cannot be related to the information about operational business capacity and volume. On the other hand the prototype provides them with information about the operational business capacity on the tactical level. It also gives them a tool to develop strategic targets which can be related to the strategic goals they currently have.

The testable construct includes the relevant information they need to monitor the strategic insight in the efficiency of the operational business capacity and volume and this is verified by interviewing experts. Yet it was noticed that the information need is diverse in a hospital, which makes difficult to limit the measurements to a small amount. In the current state the Radboudumc is developing indicators to include in the system, which brings them closer to the ideal situation. The data is available but not accessible, which made the testable construct feasible.

Also the relationship between performance drivers and outcomes is uneven (only one performance driver of the total nine is available). To manage the outcome the performance drivers are essential. A crucial performance driver is the available capacity. The indicators they currently developed give insight in the available capacity. In the current situation it cannot be concluded if the operational business capacity and volume is used efficient because the available capacity is unknown.

Oliveira (2001) and Kaplan and Norton (1996)state that the outcome (lagging) and driver (leading) are essential to achieve the desired strategy. Those values were included in the model and also the lack of them in the prototype were identified as crucial to interpret if the strategy is achieved. Lorde et al. (2008), Bamford & Chatziaslan (2009), Hwa et al. (2013) use an web based system to assure the transparency. This approach was also used to guaranty the transparency for this research. In the validation interviews, it was mentioned that a prototype and this testable construct would support the transparency. Peters et al. (2007) and Lorden et al. (2008)emphasises that this is a beneficial information about the BSC. This research also used the visual presentation of values like Wyatt (2004) suggested. Also historical trends and industry benchmarks were included in the testable construct to give the manager the option to drill down to find the cause of the problem. Chow et al. (1998) stated that the unique set of circumstances of an hospital should influenced the KPI's used. This development from theory, to design construct and then testable construct and the description of the process, will give the information to a different hospital to develop their own KPI's. Therefore it is concluded that this research also contributes to this research field in an external matter.

The contribution of this research is to develop a construct to identify information need for the internal process. This research was structured that this could be filled in by other hospitals and used as guideline to develop their own measures. Another advantage of the BSC for this research was that it emphasise the linkages of the strategy to targets. In this case there is no action defined which could measure the optimization of the process. Also the financial values cannot be directly linked to the process.

Further research should focus on the development of the other perspectives of the BSC. Also the prototype needs to be evaluated after a implementation and targets needs to be developed to have insights in the strategic goals. The process could be improved, when realised capacity and the available capacity can be monitored. Then the historical data of the process can be used to forecast.

Appendix A Literature study – the selection process

To find the right literature the approach of Wolfswinkel et al. (2013)is used. The steps in his method are define, search, select, analyse and present.

The first step is define the criteria for inclusion or exclusion. The research problem concerns different topics. Therefore different articles and theories concerning those topics are gathered. Those three main topics are, Management information system in Hospitals, Strategic alignment, Balanced Scorecard in Healthcare, Business capacity in Healthcare.

The search engine Scopus was used to conduct this research.

Management information systems in Health care

This is a search for important articles on the topic of MIS systems in hospital. To find out which kind of systems are used. Exclusion if it is only focused on one medical condition or focused on a medical specialty. This is because those information cannot give insight in the business capacity of the hospital. This research search of the keywords or search terms give about 3123 results in Scopus. Only the words management information system result in 282,994. This leads to an assumption that the 3123 results is a low number, therefore it is chosen that an article as at least 5 citations.

The word hospital could be exchanged with the word “health care” this is not used to find articles. Because the results are overall concerned with the information about “care”.

Define: “Management information system” and “hospital”

Selection phases (abstract filtering)

Requirements: iteration of select and analyse (results 45/ 20/ 7)

- Overall information about a hospital, not only one department or one aspect (like outpatients systems, or Anaesthesia systems)
- Information how to get the data in the database are acknowledged as less relevant for this research.
- Also the information about security and how to manage the information at the level of input is not relevant.
- At least 10 citations
- (Exclusion) Used the system for a quality of care aspect of data analysis (cannot be related to business capacity)
- (Exclusion) Only used for medical information or medical decision support
- Availability (12 articles were not available)

The search for business capacity was difficult topic. There were no articles distinct to only that topic. There were three articles found which have an overlay with the topic or a definition about capacity.

Define: “business capacity” and “hospital”

Selection phase (abstract filtering)

Requirements: Iteration of selection analysis (results 645/ 45/ 3)

- At least 10 citations

- (Exclusion) Used the system for a specific care aspect of data analysis (cannot be related to business capacity)
- (Exclusion) Only used for medical information
- (Exclusion)No actual information about business capacity (for example nursing resource planning, age gender details, when they leave is to detailed
- Availability (10 were not available)

Balanced scorecard in Healthcare

Define: " Balanced Scorecard" and "health care"

Requirements: Iteration of selection analysis (results 271/ 31 / 11)

- At least 30 citations (broad topic)
- (Exclusion) Only used for medical information
- Search for usage or implementing in hospitals and available
- Development of the BSC or KPI's
- Availability(not available 10)
- Balanced Scorecard in Hospitals (specific about implementation and values)

Reference to the main article about the BSC

The next step was the selection about literature about the BSC in hospitals back in forth selection of the balanced scorecard articles. The two articles from Kaplan and Norton Linking the balanced scorecard to strategy (1996) and The balanced scorecard--measures that drive performance. (1993)

Define: " hospital"

Requirements: Iteration of selection analysis (results 271/ 31 / 11)

- At least 5 citations
- Search for usage or implementing in hospitals and available
- Development of the BSC or KPI's
- Case study (comparison to this study)
- (Exclusion) Only used for medical information
- Availability
- Balanced Scorecard in Hospitals (specific about implementation and values)

Additional information about the BSC to broaden the information and to discover limitation. Articles were searched which were not written by Kaplan and Norton

Define: "Balanced Scorecard"

Requirements:

- At least 300 citations
- Not from Kaplan or Norton
- Availability

Strategy and strategic alignment

This topic was concerned broadly therefore the main topics were acknowledge in this search which are the most citations in this topic. Also back in forth search to find information about the STROBE test.

Background check about literature concerning the topic

Management information systems in Health care, this was used to identify the topic broadly and find first information about this topic. In that selection also information about lean were concerned.

Appendix B S.T.R.O.B.E test (Venkatraman, 1989)

Aggressiveness Dimension
I Sacrificing profitability to gain market share
2 Cutting prices to increase market share
3 Setting prices below competition
4 Seeking market share position at the expense of cash flow and profitability

Analysis Dimension
1 Emphasize effective coordination among different functional areas
2 Information systems provide support for decision making
3 When confronted with a major decision, we usually try to develop thorough analysis
4 Use of planning techniques
5 Use of the outputs of management information and control systems

Defensiveness Dimension
1 Significant modifications to the manufacturing technology
2 Use of cost control systems for monitoring performance
3 Use of production management techniques
4 Emphasis on product quality through the use of quality circles

Futurity Dimension
1 Our criteria for resource allocation generally reflect short-term considerations (rev)b
2 We emphasize basic research to provide us with future competitive edge
3 Forecasting key indicators of operations
4 Formal tracking of significant general trends
5 "What-if" analysis of critical issues

Proactiveness Dimension
1 Constantly seeking new opportunities related to the present operations
2 Usually the first ones to introduce new brands or products in the market
3 Constantly on the lookout for businesses that can be acquired
4 Competitors generally pre-empt us by expanding capacity ahead of them (rev)
5 Operations in larger stages of life cycle are strategic eliminated

Riskiness Dimension
1 Our operations can be generally characterized as high-risk
2 We seem to adopt a rather conservative view when making major decisions (rev)
3 New projects are approved on a "stage-by-stage" basis rather than with "blanket" approval (rev)
4 A tendency to support projects where the expected returns are certain (rev)
5 Operations have generally followed the "tried and true" paths (rev)

Appendix C Outcome of the S.T.R.O.B.E test of the Radboudumc

The Strobe test was performed with the Senior advisor who supervises this research project Those two where the sources for the following outcome. The meeting was held on 28th of May 2015. The list of questions can be found in Appendix B.

Aggressiveness Dimension

Sacrificing profitability to gain markets share. The Radboudumc is an academic hospital therefore they have to perform specialised care. These specialised treatment can help gain a new markets share, but can bring the risk of being not profitable. Yet they cannot get more revenues than is established with the health insurance companies. Radboudumc is not able to cut prices to increase the market share or can set the prices below competition, due to that every health provider negotiates the prices with the health insurance companies. Therefore their aggressiveness dimension is not strongly developed in their strategy.

Analysis Dimension

The Radboudumc has business managers (bedrijfsleiders) and head of department for each department, this emphasizes the effective coordination among different functional areas. The business managers are specialised in business operations and the head of the department is a doctor specialised in the medical specialisation of the department. The information system is built on the data from the Electronic health record(EMR) system and the planning and support systems. The information are used to build monthly reports to provide the department with the financial, workforce, capacity of utilities, revenue and registration of patients information. The department have the freedom of making individually decisions, but are controlled by the financial support department. If the Radboudumc faces to make a major decision they are commonly confronted with facts and have to act on it. When the major decision are related to an expensive investment (>100 k) they have to elaborate a business case to verify the expenditure. A thorough analysis is used to develop a business case. The Radboudumc has a monthly planning and control cycles for each department where agreements are made. They personal staff is planned within each department independent. Some departments use planning techniques and other plan it in an unstructured manner. Employees of the Radboudumc have two times a year a performance appraisal by their seniors manager. The Radboudumc use their management information and control system, but they do not use it in their full potential. The Radboudumc has the importance of analysing their information acknowledge, yet the board of directions gives the departments extensively amount of freedom to act independent. The analysis and reports are used but the spread of the advanced application is imbalanced. Defensiveness Dimension

Radboudumc tries to have a significant impact on their product, manufacturing technologies and the healthcare sector. They invest in research and education to achieve that impact. The use the cost control systems for monitoring their performance, they have to do that otherwise they would not receive the right payment from the health insurance companies. Radboudumc uses management techniques like sig sigma and lean to improve their “production” this is implemented by the internal consultancy department if medical department request it. The quality of the product/ healthcare is guaranteed by the by the legally obligated Safety Management system. Radboudumc uses methods like prospective risk assessment and decentralised reporting of incidents.

Futurity Dimension

The resources allocation is generally planned for the next financial year. Starting this year Radboudumc invest in brand recognising, which is a long term investment. Radboudumc emphasizes

basic research to establish in the market, but it should research more the position with other academic hospitals. They use forecasting as key indicator for operations, how much every department has to invest an financial budget. Radboudumc follows general trends, they have a department Reshape which is focused on following trends and being innovative, also it is given as an academic hospital to follow trends. There are not often analyses "what if" scenarios in critical management situations.

Pro-activeness Dimension

The Radboudumc should be involved to seek constantly opportunities related to present activities. The strategy of Radboudumc is to be first to introduce new brands or products in the market. Each department has their own responsibility to achieve this. Therefore this strategic point is not 100 % ensured but partly achieved. The hospital has the networking as one of their objectives to achieve their strategy, therefore it chooses not to take over other companies.

It is hard to say if competitors are pre-empt the Radboudumc of the expanding of capacity, because the academic hospitals not share that information with each other. Also the academic hospitals have to made the same agreements with the health insurances company's. The patient growth and business growth it therefore is limited to keep healthcare affordable. The Radboudumc has implemented a strategy and a planning to archives is in a larger stages of life cycles. These are planned for 3 years in advance.

Riskiness Dimension

The operations of the Radboudumc cannot be characterized as high-risk. They plan their finances generally safe and make only investments they can afford and justify. (Side note: operations here does not mean the operations on patients) The hospital view to make major decisions is planned and structured. Thus first a business case will be prepared and based on that the decision will be made. New projects can be quickly approved when they are short-term and their business case covers the cost. Long term project will be approved on a stage by stage basis to assure the benefits and the success of the project. Most implemented operations are well researched before implemented. Also there are two departments within the Radboudumc which are focused on finding and developing new methods as well as implementing them. This is not an overall standard for every department.

From this test and the analysis it can be concluded that Radboudumc has implemented their strategy and has a shared vision. Despite that there is a variation between departments on how much the strategy is implemented. Thus it is important that the departments are viewed individually because they cannot be compared with each other. The purpose of the S.T.R.O.B.E test was to identify the alignment and to identify the current situation at the Radboudumc. The outcome from this test is that the indented strategy is almost perceived as the realised strategy. Therefore the BSC will be used to identify the right measures to monitor the efficiency of the efficiency of the operational business capacity and volume of the primary process of the Radboudumc. Later on it can be concluded if the indented strategy can be found in the data of the hospital.

Appendix D Radboudumc organogram – stakeholder of the research

In this part the organisation division will be explained. The Radboudumc is a large organisation which three primary process, which are patientcare, education and research. The research will only access the process of the patientcare. Thus if it is referred to the primary process the patientcare is meant. The research is focused on the strategic insight for the board of directors. This insight should give the board of directors the ability to communicate with the departments about the efficiency of the operational business capacity and volume. It is important that they use the same information to have transparency in the communication.

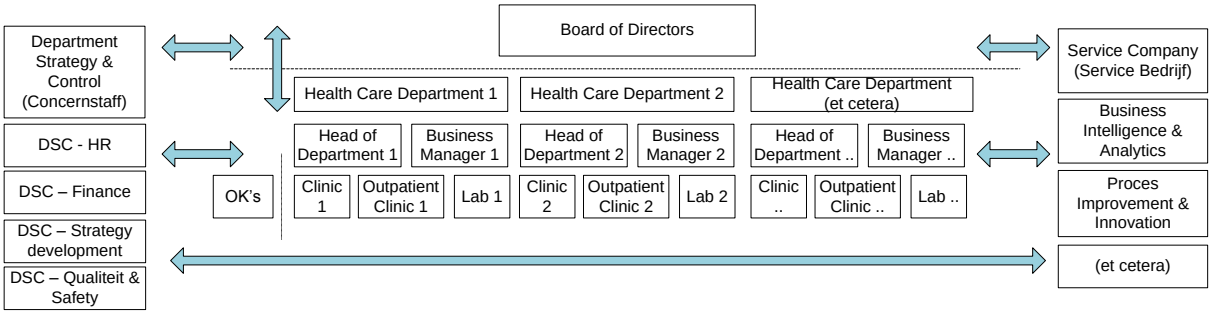


Figure 16 – Radboudumc organogram- Stakeholder of the research

The organisational division of a hospital is complex. Therefore in this organogram only the departments which are relevant for this research are shown. Above the first square the Board of Directors can be seen. The arrow goes to both sides because the relationship is not strictly downwards as it would be expected. The department strategy and control support the Board of Directors with necessary information about the HR, Finance, Strategy development and the Quality and Safety of the hospital. The DCS department supports the board with executing their task and also support the Health Care Departments, therefore they have a place on the left side. The next layer (below the Board of Directors) are the Health Care Departments, which are divided by specialism of care. The Radboudumc has 31 specialism. They do not have their own Operation Rooms, this is shared with al cutting specialism. Each department has their own Clinic and Outpatient Clinic or Lab. It should be noticed that not each specialism needs those, if it is not required in their specialism they will not have it. They Health Care Department have a Head of the Department which is a senior and expert of the specialism. The Health Care departments also have a Business Manager. This is the counterpart to the head of the department, those are not doctors or experts in the specialism. They are experts in the business and managing of departments. They have of course affection with the healthcare sector. Most commonly they have a Master Degree of a management study. They arrow from the Department Strategy and Control is also both sided. The department have a independent structured. They are able to make their own decisions, but they have to meet the agreements in terms of Finance, Strategy, HR and Quality & Safety.

On the right side the "Service Companies" can be found. This are department which support the main department. The department PVI is an internal advisor department, which perform projects for departments. The clients of those project can be anybody who has a budget in the hospital. There are also other departments like the BIA which generates the information systems for the departments. They also have a both sided arrow, because the service company can have project for each department at each level. It also has to meet the agreements in terms of Finance, Strategy, HR and Quality & Safety.

Appendix E Interviews for gathering information (dutch)

Table 5 – Interviews for gathering information

Inleiding	Uitleg	Antwoord	
Wat ga ik onderzoeken?	Strategisch inzicht in de bedrijfsdrukte		)
Wat ga ik precies meten?	Ik ga onderzoeken of er op dit moment voldoende informatie is om het gewenste inzicht te geven		)
Uitleg waarover dit gesprek gaat	In ervaring brengen wat gedaan wordt met de bedrijfsproces data		)
Wat is hun toevoeging/ bijdraag?	Eigen ervaring kennis inbrengen als expert		)
Doelmatigheid van bedrijfsprocessen (bedrijfsdrukte)			
Wat betekent doelmatigheid van bedrijfsprocessen voor u?	Om zeker te gaan dat wij dezelfde definitie hebben		)
Welke informatie en meetwaardes vindt u relevant ervoor?	Buiten beschouwing laten, van wat er nu gerapporteerd, gemeten of bij gehouden wordt.		)
In welke waardes spelen een grote rol in dagelijkse of wekelijkse handelingen?	Welke waardes zijn dag te dag waardes		)
Welke waardes zelden? Maandelijks of jaarlijks en waarom?	Langer termijn planning		)
In welke mate vorm worden die waardes ingezet om ervan te leren?	Met het idee op lean of verbeteren		)
Bij welke waarde heeft u het gevoel met zekerheid te zeggen dat de processen doelmatig zijn?	Efficiënt en effectieve benut van de resources		)

Hebt U inzicht in hoe verre dat ingezien of belang vind bij de Raad van Bestuur?	Of welke punten bijzonders veel aandacht krijgen?		)

Appendix FIdeal indicators and available indicators

		Measurements	OR	Outpatient Clinic	Clinic	Literature
Performance Drivers	Relationship	% Of Outpatient Clinic/ OR / Clinic will got to another of those mentioned	Not Available	Not Available	Not Available	Not mentioned
	Planning	Availability Beds / OR/ Staff	In development	In development	In development	Yes
	Planning	Reserved Beds/ OR/Staff (emergency)	In development	In development	In development	Yes
	Planning	Scheduled Beds/ OR/ Staff	Available	In development	Not Available	Yes
Outcome	Volume	# Patients/ visits/ operations / beds	Available	Available	Available	Yes
	Volume	Cumulative/ total patients/visits/ operations	Available	Available	Available	Yes
	Volume	Time per visits/operations	Available	Available	Available	Not mentioned
	Capacity Realised	% Number of patients/visits/ OR to other years%	Available	Available	Available	Not mentioned
	Capacity Realised	% Realised to planned	Available	In development	Not Available	Not mentioned
	Capacity Realised	Hours per Staff	Available	Available	Not Available	Yes
	Capacity Realised	Number of patient/ visits/ OR per staff	Available	Available	Not Available	Yes
	Shortcomings	Cancellation/no shows	Available	Available	Not Available	Not mentioned

	Shortcomings	Delay /Longer than planned	Available	Not Available	Not Available	Yes
	Shortcomings	Not realised to other years	Not Available	Not Available	Not Available	Not mentioned
	Measure & Improve	Long term analysis of fluctuation	Not Available	Not Available	Not Available	Not mentioned
	Measure & Improve	Benchmark internal	Available	Not Available	Not Available	Yes
	Measure & Improve	Benchmark external	In development	Not Available	Not Available	Yes

Table 6 – Ideal indicators and available indicators

Appendix G Ideal indicators and current used indicators

Table 7 – Ideal indicators and current used indicators

		Measurement	OR	Outpatient Clinic	Clinic
Performance Drivers	Relationship	% Of Outpatient Clinic/ OR / Clinic will got to another of those mentioned	Not Used	Not Used	Not Used
	Planning	Availability Beds / OR/ Staff	Not Used	Not Used	Not Used
	Planning	Reserved Beds/ OR/Staff (emergency)	Not Used	Not Used	Not Used
	Planning	Scheduled Beds/ OR/ Staff	Used	Not Used	Used
Outcome	Volume	# Patients/ visits/ operations / beds	Used	Used	Used
	Volume	Cumulative/ total patients/visits/ operations	Not Used	Used	Used
	Volume	Time per visits/operations	Used	Not Used	Not Used
	Capacity Realised	% Number of patients/visits/ OR to other years%	Not Used	Not Used	Not Used
	Capacity Realised	% Realised to planned	Used	Not Used	Not Used
	Capacity Realised	Hours per Staff	Not Used	Not Used	Not Used
	Capacity Realised	Number of patient/ visits/ OR per staff	Not Used	Not Used	Not Used
	Shortcomings	Cancellation/no shows	Not Used	Used	Not Used
	Shortcomings	Delay /Longer than planned	Used	Not Used	Not Used
	Shortcomings	Not realised to other years	Not Used	Not Used	Not Used
	Measure & Improve	Long term analysis of fluctuation	Not Used	Not Used	Not Used
	Measure & Improve	Benchmark internal	Not Used	Not Used	Not Used
	Measure &	Benchmark external	Not	Not Used	Not Used

	Improve		Used		

Appendix H Indicators from the Interviewees

Table 8 – Indicators from Interviewees

Indicators from the Interviewees	Report status	Testable construct	Literature
Admissions per bed	Not used	Not in testable construct	Not found
Admissions per FTE	Not used	Not in testable construct	Not found
Material Room information	Not used	Not in testable construct	Not found
Relationship OK, Outpatient Clinic and Clinic(Planning)	Not used	Not in testable construct	Not found
Laboratory information	Not used	Not in testable construct	Literature
OR location	Not used	Not in testable construct	Not found
Financial indicators (cost per)	Not used	Not in testable construct	Literature
Availability of beds and doctors	Not used	Testable construct	Literature
Average time per surgery / head	Not used	Testable construct	Literature
External benchmarking	Not used	Testable construct	Literature
FTE per bed	Not used	Testable construct	Literature
Hours per employee	Not used	Testable construct	Literature
Outpatient Clinic days how many hours per arts	Not used	Testable construct	Literature
Outpatient Clinic utilization	Not used	Testable construct	Literature
Planning Admission	Not used	Testable construct	Literature
Relationship OK Outpatient clinic and Clinic	Not used	Testable construct	Not found
Work cycle of the staff	Not used	Testable construct	Literature
New Consult	Used	Not in testable	Literature

		construct	
Number of beds	Used	Testable construct	Literature
Ok hours	Used	Testable construct	Literature
Ok utilization	Used	Testable construct	Literature
Planning OK	Used	Testable construct	Literature
OR clean and switch time	Used	Testable construct	Literature
Waiting lists	Not used	Not in testable construct	Literature

Appendix I Interviews for validation (*Dutch*)

Table 9 – Interview for validation (Dutch)

Inleiding	Antwoord	
1 Introduction of the Researcher 2 Research objective 3 Goal of the interview: To gather insights about the business capacity at the Radboudumc and validate the prototype 4 Duration: 1 hour / 1,5 hour		○
Wat ga ik onderzoeken?		○
Wat ga ik precies meten?		○
Uitleg waarover dit gesprek gaat		○
Wat is hun toevoeging/ bijdraag?		○
Operational business capacity and volume		
First presenting the Design Construct and the Testable construct		○
Wat betekent doelmatigheid van bedrijfsdrukte voor u/je?		○
Hoe belangrijk lijkt je/uw het om goed inzicht te hebben op de planning om de efficiency te monitoren?		○
Heet u/je op dit moment inzicht in de planning en realisatie van de		○

bedrijfsdrukte?		
Denkt uw dat het monitoren van de planning nadelige effecten kan hebben voor de afdelingen?		○
		Presentation of the Prototype
In between the prototype is presented with the indicators. The interviewee can give at any point feedback about the prototype.		○
Heeft u/ je het gevoel nu nieuwe informatie of inzichten te hebben?		○
Welke waardes of informatie mist u nu nog om daadwerkelijk een goed beeld te hebben van de bedrijfsdrukte van het Radboudumc		○
		Observations
Does the interviewee understand the prototype?		○
Is the interaction with the prototype relevant or irrelevant?		○
Is the presentation of the indicators an concern within the communication?		○

Appendix J Improvements Indicators from the interviews (Dutch)

In this part the improvements are described. Those are formulated in Dutch this information is confidential. Those are 70 variables 30 of them were dismissed, because there were not achievable or not desired to include in the model.

Nr	Datum	Verbeterpunt	Status van afronding
1	22-7-2015	Duur van afspraken	Afgerond
1	22-7-2015	Hoeveel Polidagen/ tijd per medewerker	Afgerond
7	13-8-2015	Informatie geven of er minder mensen ingezet worden als er minder patienten zijn	Afgewezen
2	27-7-2015	Geannuleerd uit de verdeling percentage eruit halen	Afgewezen
2	27-7-2015	Wie heeft het geannuleerd?	Afgewezen
11	4-9-2015	Bij de annulering de aantallen toevoegen	Afgewezen
4	10-8-2015	annuleringsreden wel interessant	Afgewezen
1	22-7-2015	Geannuleerde OK's	Afgerond
2	27-7-2015	Beschikbare capaciteit, ingezette middelen (bijvoorbeeld heelkunde heeft nu 12 bedden dicht, kan ik dat ergens anders zien? Valt wel op in de opnames)	Afgewezen
2	27-7-2015	Code groepering lastig radboudumcbreedt?	Afgewezen
2	27-7-2015	Coderingen van verrichtingen	Afgewezen
2	27-7-2015	Ziekte beelden	Afgewezen
2	27-7-2015	Correcties gebeuren nog 2 weken achteraf, datum van data ontsluiting inzetten	Afgewezen
2	27-7-2015	Dubbel tellingen voorkommen? Iemand die met spoed binnenkomt wordt achteraf kliniek is die dubbel geteld	Afgewezen

2	27-7-2015	Hoe worden Interne Controle Consulten op de kliniek geregistreerd ook in de agenda?	Afgewezen
2	27-7-2015	Hoofdoperateur & medeinvoer (specialisme, geen dubbel tellingen maar specialisme deelt het)	Afgerond
1	22-7-2015	Kan Spoed afspraken hebben?	Afgerond
5	11-8-2015	Onbekend laten zien	Afgerond
8	18-8-2015	Externe Benchmark toevoegen	Afgewezen
3	30-7-2015	Euro's aan koppelen zou een veel betere inzicht geven	Afgewezen
11	4-9-2015	overzicht per UMC	Afgerond
6	13-8-2015	Generale overzicht voor RvB.	Afgerond
8	18-8-2015	1 overzicht met de essentieelste informatie, welke zeggen het sterkst iets over de capaciteit	Afgerond
9	18-8-2015	1 Hoofdniveau toevoegen met de trend van Poli, OK, Kliniek	Afgerond
2	27-7-2015	Laten zien welke afspraken erin zitten, telefonisch, facetalk	Afgewezen
6	13-8-2015	Duidelijk neer zetten welke informatie getoond worden	Afgerond
9	18-8-2015	Vraagstelling concretiseren per overzicht	Afgerond
7	13-8-2015	Informatieveld met uitleg toevoegen: afwijkingen kunnen oorzaak hebben dat afdeling hun strategie verandert hebben	Afgewezen
7	13-8-2015	Informatieveld met uitleg toevoegen: Invoer fouten worden getoond	Afgewezen
2	27-7-2015	Diagnostiek stukje MRI lab Zorgactiviteitlabel	Afgewezen
2	27-7-2015	Ligdagen zou leuk zijn minder te zien	Afgerond

3	30-7-2015	Verpleegdagen	Afgerond
7	13-8-2015	Ligduur in uren/ dagen	Afgerond
4	10-8-2015	nieuwe afspraken kijken of de informatie wel klopt	Afgewezen
6	13-8-2015	Nieuwe consulten toevoegen	Afgewezen
5	11-8-2015	Niet nieuwe Consult/ wel nieuwe afspraak	Afgewezen
10	24-8-2015	Nieuwe consulten toevoegen	Afgewezen
5	11-8-2015	No-shows aanpassen als het Radboudumc	Afgewezen
2	27-7-2015	Veel tegen over weinig aantallen zegt überhaupt niets zonder de duur	Afgerond
1	22-7-2015	Hoeveel Ok uren per personeel	Afgerond
2	27-7-2015	Waar locatie	Afgewezen
2	27-7-2015	Uitvoerder	Afgerond
2	27-7-2015	Benutte sessie van plannend, staat in EPIC wordt getoond in het Schipholboard	Afgerond
4	10-8-2015	Ok benutting handig om weer te geven	Afgerond
6	13-8-2015	Ok planning	Afgerond
6	13-8-2015	Ok Benutting toevoegen	Afgerond
1	22-7-2015	OK planning	Afgerond
1	22-7-2015	OK wisseltijd	Afgewezen

11	4-9-2015	per duur een aantallen per medewerker	Afgerond
3	30-7-2015	Veel beter inzicht, maar capaciteit mist hierbij nog daarom niet helemaal strategisch	Afgerond
2	27-7-2015	Opnames per codes Diagnose	Afgewezen
3	30-7-2015	meer opnames minder patiënten?	Afgerond
5	11-8-2015	Snijtijd percentage verschil interessanter	Afgerond
3	30-7-2015	verschil tussen OK tijd = Wisseltijd lager efficiënter omdat wisseltijd opzicht niet verandert in hetzelfde specialisme	Afgerond
11	4-9-2015	Per Specialisme	Afgerond
9	18-8-2015	3 lagen toevoegen waar een alleen over poli/ Ok/ kliniek gaat	Afgerond
11	4-9-2015	Uitloop toevoegen	Afgerond
10	24-8-2015	Waardes uit andere Systemen als MijnTijd en Harmony	Afgewezen
2	27-7-2015	Niet duidelijk eerste goed, zelfde kleur, zelfde schaal lijkt allemaal wat onrustig daardoor	Afgerond
2	27-7-2015	Percentage in patroon duidelijk laten zien half jaar	Afgerond
8	18-8-2015	Alfabetisch sorteren daarmee die vergelijking niet tussen de afdeling gemaakt worden	Afgewezen
8	18-8-2015	Informatieoverload in korten met 1 overzicht	Afgerond
5	11-8-2015	Ok duur niet rood – groen	Afgerond
9	18-8-2015	Altijd zelfde volgordes voor de meetwaardes: 1e aantallen	Afgerond
9	18-8-2015	Altijd zelfde volgordes voor de meetwaardes: 2e gemiddeldes	Afgerond

9	18-8-2015	Altijd zelfde volgordes voor de meetwaardes: 3e percentage verschillen met jaar ervoor (in ieder geval direct naar de waarde waar het om gaat)	Afgerond
1	22-7-2015	Wachtlijsten	Afgewezen
5	11-8-2015	Wisseltijd om benoemen	Afgerond
2	27-7-2015	YTD overzicht	Afgerond
3	30-7-2015	Het zou mooi zijn om combinaties te maken met DOT's en plafonds, Poli, Kliniek en OK is heel erg van de oude tijdperk van financiering.	Afgewezen

Table 10 – Improvements Measures from the interviews

Appendix K Dutch healthcare system

The Dutch government has to establish a healthcare system where the public interest is secured. The introduction of the health Insurance Law of 2006 launched a healthcare system where regulated competition for curative healthcare is possible (van den Berg et al., 2014).

The competition is regulated when through legislation there are imposed restrictions on the free market. The expected advantages are that the public's interest as quality, accessibility and affordability of care will be secured.

There will be differentiated between three markets:

- Health insurance market
- Healthcare purchase market
- Healthcare provision market

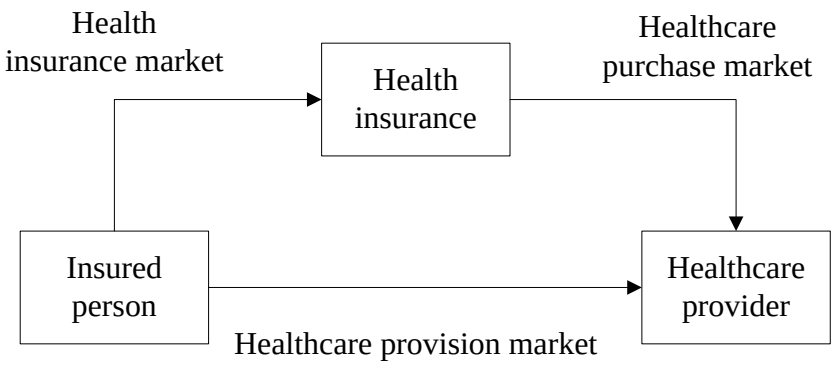


Figure 17 – Dutch Healthcare system

The health insurance companies try to make attractive offers to the public. Almost everybody is legally obligated to conclude a basic health insurance contract. The content of this basic health insurance contract is specified by the government. The free choice of a health insurance company is the health insurance market (van den Berg et al., 2014).

The healthcare purchase market is where the health insurance companies negotiation the conditions of Insurance contract with the healthcare providers. In those negotiations the healthcare provider and the health insurance companies agree on the price, quality and volume of care. The health insurance companies can compete with each other, because every health insurance company has their own conditions of insurances.

De health Insurance companies create the linkages between the insured person and the healthcare provider. The competition on quality in healthcare is compounded when the insured person is able to make an informed choice between providers. The healthcare provision market is different than the other two markets because the health insurance companies are the intermediaries between the insured person and the healthcare provider.

Hospitals are healthcare providers. In the healthcare purchase market they agree on the prices, quality and volume of care. Therefore a hospital has a limit on how much they are able to grow. This is to make sure that healthcare is sustainable and affordable for the public in the Netherlands.

The detailed level of the financial model is that the diagnose and the treatment of patient is linked on diagnostic treatment combination (Diagnose Behandel Combinatie : DBC). This describes each care pathway which is possible from the diagnose to the treatment. This were about 30.000 different codes, this were changed to the system of DOT. That are the DBC on the way to be more transparent (DBC op weg naar transparantie) which groups the DBS to a number of 4.400 codes. The systems is used to declare the cost and to get the money from the health insurance companies. (Nederlandse zorgautoriteit, 2015)

Appendix L BSC indicators from literature

Table 11 – Literature indicators

Balanced scorecard indicators	Perspective	Author	Research topic
Discharge diagnoses	Clinical productivity and efficiency	Applegate et al. (1986)	MIS
Customer reactions to change	Customer satisfaction	Applegate et al. (1986)	MIS
Costs of services	Financial	Applegate et al. (1986)	MIS
Facilities/operations utilization and costs	Financial	Applegate et al. (1986)	MIS
Personnel job descriptions and salary schedules	Financial	Applegate et al. (1986)	MIS
Service descriptions and cost categories	Financial	Applegate et al. (1986)	MIS
Administrative support required for services	Internal operations	Applegate et al. (1986)	MIS
Admissions	Internal operations	Applegate et al. (1986)	MIS
Average length of stay	Internal operations	Applegate et al. (1986)	MIS
Bed utilization	Internal operations	Applegate et al. (1986)	MIS
Patient days	Internal operations	Applegate et al. (1986)	MIS
Personnel workloads	Internal operations	Applegate et al. (1986)	MIS
Activity targets	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Capacity utilisation – strategic performance targets	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Financial data (cost per clinic)	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Fit with clinician's annual assessment	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Comparison of performance against targets	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Connection with NHS targets	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.

Facilitate forward capacity planning as well as report on past performance	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Increase transparency and accountability for the individual clinical teams	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Assess the activity in their clinics	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Connection with their assessment	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
New: follow-up ratios	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
Use of clinic capacity	operational activity	Bamford & Chatziaslan (2009)	BSC Impl.
accurate diagnosis rate	Customer perspective	Chow et al. (1998)	BSC
Admission times	Customer perspective	Chow et al. (1998)	BSC
and increased donations	Customer perspective	Chow et al. (1998)	BSC
community perception surveys	Customer perspective	Chow et al. (1998)	BSC
cycle time	Customer perspective	Chow et al. (1998)	BSC
degree of automation	Customer perspective	Chow et al. (1998)	BSC
delivered on time	Customer perspective	Chow et al. (1998)	BSC
favourable press coverage	Customer perspective	Chow et al. (1998)	BSC
market share	Customer perspective	Chow et al. (1998)	BSC
patient referrals	Customer perspective	Chow et al. (1998)	BSC
patient satisfaction	Customer perspective	Chow et al. (1998)	BSC
quality encompasses the tests performed	Customer perspective	Chow et al. (1998)	BSC
quality of medical care and prompt service, emergency room	Customer perspective	Chow et al. (1998)	BSC
repeat patients	Customer perspective	Chow et al. (1998)	BSC
retention rate of good doctors	Customer perspective	Chow et al. (1998)	BSC
the services rendered	Customer perspective	Chow et al. (1998)	BSC
Activities as a gauge for progress in obtaining	Financial Perspective	Chow et al. (1998)	BSC

community support.			
bed vacancy levels	Financial Perspective	Chow et al. (1998)	BSC
budget considerations	Financial Perspective	Chow et al. (1998)	BSC
cash flows	Financial Perspective	Chow et al. (1998)	BSC
Considerations.	Financial Perspective	Chow et al. (1998)	BSC
dollars from fundraising	Financial Perspective	Chow et al. (1998)	BSC
dollars generated from new contracts and percentage of contracts relative to competitors	Financial Perspective	Chow et al. (1998)	BSC
for financial goal attainment included market share,	Financial Perspective	Chow et al. (1998)	BSC
Rate of growth in cash inflows.	Financial Perspective	Chow et al. (1998)	BSC
reducing emergency room	Financial Perspective	Chow et al. (1998)	BSC
Referrals, and number of increased contracts with (HMOs), Medical, and Medicare.	Financial Perspective	Chow et al. (1998)	BSC
amount of doctor research activities	Innovation and Learning Perspective	Chow et al. (1998)	BSC
continuous improvement	Innovation and Learning Perspective	Chow et al. (1998)	BSC
cost/benefit analysis	Innovation and Learning Perspective	Chow et al. (1998)	BSC
Feedback from doctors and customers.	Innovation and Learning Perspective	Chow et al. (1998)	BSC
number and quality of new services	Innovation and Learning Perspective	Chow et al. (1998)	BSC
number of employees attending educational and training seminars, conferences, and workshops	Innovation and Learning Perspective	Chow et al. (1998)	BSC
number of new procedures	Innovation and Learning Perspective	Chow et al. (1998)	BSC
number of ongoing instructional development programs	Innovation and Learning Perspective	Chow et al. (1998)	BSC
number of professional presentations	Innovation and	Chow et al. (1998)	BSC

	Learning Perspective		
publications	Innovation and Learning Perspective	Chow et al. (1998)	BSC
state of the art technology	Innovation and Learning Perspective	Chow et al. (1998)	BSC
Surveys of employee satisfaction.	Innovation and Learning Perspective	Chow et al. (1998)	BSC
complaint rates	Internal Business	Chow et al. (1998)	BSC
Cost per diagnosis	Internal Business	Chow et al. (1998)	BSC
cost per procedure	Internal Business	Chow et al. (1998)	BSC
cost per test (as a measure of efficiency)	Internal Business	Chow et al. (1998)	BSC
Costs per patient day	Internal Business	Chow et al. (1998)	BSC
Cycle time and turnaround	Internal Business	Chow et al. (1998)	BSC
doctor satisfaction,	Internal Business	Chow et al. (1998)	BSC
effective contracting	Internal Business	Chow et al. (1998)	BSC
effective use of resources	Internal Business	Chow et al. (1998)	BSC
increasing contracting	Internal Business	Chow et al. (1998)	BSC
other satisfaction surveys	Internal Business	Chow et al. (1998)	BSC
Clinical productivity per physician per workday	Clinical productivity and efficiency	Curtright et al. (2000)	MIS
Outpatient visits per physician per workday	Clinical productivity and efficiency	Curtright et al. (2000)	MIS
Rating of primary care provided	Customer satisfaction	Curtright et al. (2000)	MIS
Rating of subspecialty care provided	Customer satisfaction	Curtright et al. (2000)	MIS
Board of Governors' environmental scan	External environmental assessment	Curtright et al. (2000)	MIS
Market share	External environmental assessment	Curtright et al. (2000)	MIS

Expense per relative value unit (unit of service)	Financial	Curtright et al. (2000)	MIS
General examination average itinerary length in days	Internal operations	Curtright et al. (2000)	MIS
Patient complaints per 1,000 patients	Internal operations	Curtright et al. (2000)	MIS
Patient waiting times—access to appointments	Internal operations	Curtright et al. (2000)	MIS
Employee satisfaction surveys	Mutual respect and diversity	Curtright et al. (2000)	MIS
Percentage of staff from underrepresented groups	Mutual respect and diversity	Curtright et al. (2000)	MIS
Patient mix by geography and payer group	Patient characteristics	Curtright et al. (2000)	MIS
Mayo's contribution to society	Social commitment	Curtright et al. (2000)	MIS
Patient satisfaction index	Customer perspective	Grigoroudis et al. (2012)	BSC
Number of patient complaints	Customer perspective	Grigoroudis et al. (2012)	BSC
Average waiting time	Customer perspective	Grigoroudis et al. (2012)	BSC
Hospital beds per 1000 people	Customer perspective	Grigoroudis et al. (2012)	BSC
Percentage of cases transferred to other hospitals	Customer perspective	Grigoroudis et al. (2012)	BSC
Percentage of readmissions	Customer perspective	Grigoroudis et al. (2012)	BSC
Average duration of hospitalisation	Customer perspective	Grigoroudis et al. (2012)	BSC
Net profit margin	Financial Perspective	Grigoroudis et al. (2012)	BSC
Operating revenues to assets ratio	Financial Perspective	Grigoroudis et al. (2012)	BSC
Current ratio	Financial Perspective	Grigoroudis et al. (2012)	BSC
Debt ratio	Financial Perspective	Grigoroudis et al. (2012)	BSC
Inventory turnover	Financial Perspective	Grigoroudis et al. (2012)	BSC
Operating expenses to operating revenues ratio	Financial Perspective	Grigoroudis et al. (2012)	BSC
Number of projects with other organisations	Innovation and Learning Perspective	Grigoroudis et al. (2012)	BSC

Percentage of budget used for purchase of new technology	Innovation and Learning Perspective	Grigoroudis et al. (2012)	BSC
Resource allocation to information technology/capital	Innovation and Learning Perspective	Grigoroudis et al. (2012)	BSC
Percentage of employees trained(nursing and other)	Innovation and Learning Perspective	Grigoroudis et al. (2012)	BSC
Percentage of medical staff participate into conferences	Innovation and Learning Perspective	Grigoroudis et al. (2012)	BSC
Employee satisfaction index(medical)	Internal Business	Grigoroudis et al. (2012)	BSC
Employee satisfaction index(nursing and other)	Internal Business	Grigoroudis et al. (2012)	BSC
Employee retention index	Internal Business	Grigoroudis et al. (2012)	BSC
Employee absenteeism index	Internal Business	Grigoroudis et al. (2012)	BSC
Surplus inventory	Internal Business	Grigoroudis et al. (2012)	BSC
Bed occupancy ratio	Internal Business	Grigoroudis et al. (2012)	BSC
HCAHOS Top Box MD Communication	Customers	Hwa et al. (2013)	BSC Impl.
Quality Incentive Metrics Performance	Customers	Hwa et al. (2013)	BSC Impl.
Job satisfaction Rating	Customers	Hwa et al. (2013)	BSC Impl.
Rate of Appropriate History and Physical Level 3 Documentation	Financial Perspective	Hwa et al. (2013)	BSC Impl.
Total yearly Grant Funding	Financial Perspective	Hwa et al. (2013)	BSC Impl.
Quality Incentive Metrics	Financial Perspective	Hwa et al. (2013)	BSC Impl.
Mortality Index	Internal Processes	Hwa et al. (2013)	BSC Impl.
All 30 day readmissions	Internal Processes	Hwa et al. (2013)	BSC Impl.
Timely Follow up After discharge	Internal Processes	Hwa et al. (2013)	BSC Impl.

PCP Communication at Discharge	Internal Processes	Hwa et al. (2013)	BSC Impl.
Hand Hygiene Rates	Internal Processes	Hwa et al. (2013)	BSC Impl.
Pneumonia Antibiotic Selection	Internal Processes	Hwa et al. (2013)	BSC Impl.
Length of Stay Index	Internal Processes	Hwa et al. (2013)	BSC Impl.
Direct Cost per Case	Internal Processes	Hwa et al. (2013)	BSC Impl.
Timely Evaluation Completion	Internal Processes	Hwa et al. (2013)	BSC Impl.
Evaluation Teaching and Skills	Internal Processes	Hwa et al. (2013)	BSC Impl.
Evaluation Overall Rating	Internal Processes	Hwa et al. (2013)	BSC Impl.
# of Peer Reviewed Publications published per year	Internal Processes	Hwa et al. (2013)	BSC Impl.
# of abstracts accepted at meetings (local or national)	Internal Processes	Hwa et al. (2013)	BSC Impl.
# on Non-Peer reviewed publications	Internal Processes	Hwa et al. (2013)	BSC Impl.
% of Faculty attending at least 1 Development Meeting each month	Learning and Growth	Hwa et al. (2013)	BSC Impl.
encompassed team work	best people	Lorden et al. 2008	BSC Impl.
employee turnover	best people	Lorden et al. 2008	BSC Impl.
employee satisfaction	best people	Lorden et al. 2008	BSC Impl.
employee involvement	best people	Lorden et al. 2008	BSC Impl.
patient satisfaction scores	customer service	Lorden et al. 2008	BSC Impl.

Medicare length of stay	Financial Perspective	Lorden et al. 2008	BSC Impl.
gain from operations	Financial Perspective	Lorden et al. 2008	BSC Impl.
net income	Financial Perspective	Lorden et al. 2008	BSC Impl.
operating margin	Financial Perspective	Lorden et al. 2008	BSC Impl.
debt service ratio	Financial Perspective	Lorden et al. 2008	BSC Impl.
utilized occurrences of inpatient acute myocardial infraction	quality of care	Lorden et al. 2008	BSC Impl.
mortality and pneumonia antibiotics coverage within 4 and 8 hours	quality of care	Lorden et al. 2008	BSC Impl.
discharge rate	Clinical productivity and efficiency	Naranjo-Gil and Hartmann (2007)	MIS
number of treatments	Clinical productivity and efficiency	Naranjo-Gil and Hartmann (2007)	MIS
staff absenteeism	Clinical productivity and efficiency	Naranjo-Gil and Hartmann (2007)	MIS
cost information per patient	Financial	Naranjo-Gil and Hartmann (2007)	MIS
Cost per patient/service	Financial	Naranjo-Gil and Hartmann (2007)	MIS
bed occupancy	Internal operations	Naranjo-Gil and Hartmann (2007)	MIS
Customer satisfaction survey	Customer	Oliveira (2001)	BSC
Health plan market share	Customer	Oliveira (2001)	BSC
Cardiology practice market share	Customer	Oliveira (2001)	BSC
SFF-36 health survey results	Customer	Oliveira (2001)	BSC
Marketing focus group	Customer	Oliveira (2001)	BSC
Percentage of clinical cause of treatment education provide to patients	Customer	Oliveira (2001)	BSC

Marketing budget per payer contract	Customer	Oliveira (2001)	BSC
Number of cardiology physician practise affiliation	Customer	Oliveira (2001)	BSC
Percentage of patient on clinical pathway for congestive heart failure	Customer	Oliveira (2001)	BSC
Advertising budget per bed	Customer	Oliveira (2001)	BSC
Average total cost per case	Financial Perspective	Oliveira (2001)	BSC
Bond rating	Financial Perspective	Oliveira (2001)	BSC
Profit margin of managed core paver volume	Financial Perspective	Oliveira (2001)	BSC
Average length of stay	Financial Perspective	Oliveira (2001)	BSC
Debt financing load	Financial Perspective	Oliveira (2001)	BSC
Capitated payer contracts	Financial Perspective	Oliveira (2001)	BSC
Strategic skill rating	Human Resources	Oliveira (2001)	BSC
Employee climate survey	Human Resources	Oliveira (2001)	BSC
Percentage of board certified physicians	Human Resources	Oliveira (2001)	BSC
Percentage of clinical staff who receive change management training	Human Resources	Oliveira (2001)	BSC
Cardiac emergency department	Internal	Oliveira (2001)	BSC
Clinical resource consumption index relative to national benchmark	Internal	Oliveira (2001)	BSC
Days in account receivable	Internal	Oliveira (2001)	BSC
Prophylactic aspiring upon emergency department discharge	Internal	Oliveira (2001)	BSC
research grand funding as a percentage of cardiology operation budget	Internal	Oliveira (2001)	BSC
Percentage of denied demands due to missing information	Internal	Oliveira (2001)	BSC
Not mentioned	capacity for service provision (structural inputs)	Peters et al. (2007)	BSC

Not mentioned	Financial systems	Peters et al. (2007)	BSC
Not mentioned	overall vision for the health sector	Peters et al. (2007)	BSC
Not mentioned	patient perspectives	Peters et al. (2007)	BSC
Not mentioned	service provision (technical quality)	Peters et al. (2007)	BSC
Not mentioned	staff perspectives	Peters et al. (2007)	BSC
Facilities and services offered	Clinical productivity and efficiency	Pierskalla and Woods (1988)	MIS
Number of full-time equivalent employees	Clinical productivity and efficiency	Pierskalla and Woods (1988)	MIS
Admission date	Internal operations	Pierskalla and Woods (1988)	MIS
Inpatient days	Internal operations	Pierskalla and Woods (1988)	MIS
Licensed bed capacity	Internal operations	Pierskalla and Woods (1988)	MIS
Number of admissions	Internal operations	Pierskalla and Woods (1988)	MIS
Occupancy rate	Internal operations	Pierskalla and Woods (1988)	MIS
Principal specialties at office location	Internal operations	Pierskalla and Woods (1988)	MIS
Office location	Other	Pierskalla and Woods (1988)	MIS
Census tract of location	Other	Pierskalla and Woods (1988)	MIS
Census tract of residence	Other	Pierskalla and Woods (1988)	MIS
Hospital attended	Other	Pierskalla and Woods (1988)	MIS
Hospital facilities	Other	Pierskalla and Woods (1988)	MIS

Hospital service	Other	Pierskalla and Woods (1988)	MIS
Hospitals with full admitting privileges	Other	Pierskalla and Woods (1988)	MIS
Age	Patient characteristics	Pierskalla and Woods (1988)	MIS
Race	Patient characteristics	Pierskalla and Woods (1988)	MIS
Sex	Patient characteristics	Pierskalla and Woods (1988)	MIS
Socioeconomic class	Patient characteristics	Pierskalla and Woods (1988)	MIS
Not mentioned	Clinical Utilization and Outcome	Pink et al. (2001)	BSC Impl.
Not mentioned	Financial Performance & Condition	Pink et al. (2001)	BSC Impl.
Not mentioned	Patient Satisfaction	Pink et al. (2001)	BSC Impl.
Not mentioned	System Integration and Change	Pink et al. (2001)	BSC Impl.
effectiveness	Consumer perspective	ten Asbroek et al., (2004)	BSC
patient safety	Consumer perspective	ten Asbroek et al., (2004)	BSC
patient centeredness	Consumer perspective	ten Asbroek et al., (2004)	BSC
health system costs	Financial perspective	ten Asbroek et al., (2004)	BSC
allocative efficiency	Financial perspective	ten Asbroek et al., (2004)	BSC
vertical equity	Financial perspective	ten Asbroek et al., (2004)	BSC
financial accessibility	Financial perspective	ten Asbroek et al., (2004)	BSC
financial viability of financiers and care providers	Financial perspective	ten Asbroek et al., (2004)	BSC

allocation of funds for learning and growth	Innovation perspective	ten Asbroek et al., (2004)	BSC
diffusion of new technologies	Innovation perspective	ten Asbroek et al., (2004)	BSC
information infrastructure	Innovation perspective	ten Asbroek et al., (2004)	BSC
human resources (2): innovative working environment, and professionals in training	Innovation perspective	ten Asbroek et al., (2004)	BSC
development and diffusion of organisational innovations	Innovation perspective	ten Asbroek et al., (2004)	BSC
industry initiated research and development activities in health care	Innovation perspective	ten Asbroek et al., (2004)	BSC
performance of care financiers	Internal business processes perspective	ten Asbroek et al., (2004)	BSC
quality of health care delivery process	Internal business processes perspective	ten Asbroek et al., (2004)	BSC
availability of choice of insurer and provider	Internal business processes perspective	ten Asbroek et al., (2004)	BSC
concentration of care provision	Internal business processes perspective	ten Asbroek et al., (2004)	BSC
human resources (1) : availability, vacancies, and staff satisfaction	Internal business processes perspective	ten Asbroek et al., (2004)	BSC
substitution of care between professions and between care delivery settings	Internal business processes perspective	ten Asbroek et al., (2004)	BSC
Environmental awareness	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Effective use of IT	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Patient safety	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Access to care	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Equipment effectiveness	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.

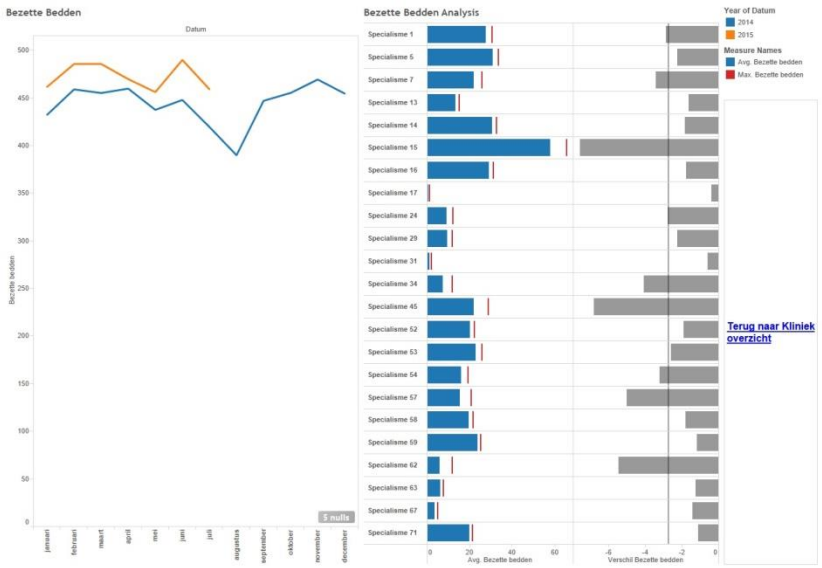
Equipment management	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Operational excellence	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Process excellence	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Effective use of facility	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Data quality	Clinical focus	Türkeli & Erçek (2010)	BSC Impl.
Cost optimisation	Financial Perspective	Türkeli & Erçek (2010)	BSC Impl.
Sustainable growth	Financial Perspective	Türkeli & Erçek (2010)	BSC Impl.
Efficient knowledge production	Learning and Growth	Türkeli & Erçek (2010)	BSC Impl.
Staff satisfaction Learning	Learning and Growth	Türkeli & Erçek (2010)	BSC Impl.
Effective staff development	Learning and Growth	Türkeli & Erçek (2010)	BSC Impl.
Improve quality of communication	Learning and Growth	Türkeli & Erçek (2010)	BSC Impl.
Effective management of IT knowledge	Learning and Growth	Türkeli & Erçek (2010)	BSC Impl.
Establish continuous improvement culture	Learning and Growth	Türkeli & Erçek (2010)	BSC Impl.
Equal service	Patient focus	Türkeli & Erçek (2010)	BSC Impl.
Patient care	Patient focus	Türkeli & Erçek (2010)	BSC Impl.
Patient satisfaction	Patient focus	Türkeli & Erçek (2010)	BSC Impl.
Monthly surgical cases (out and inpatient)	Clinical productivity and efficiency	Wyatt (2004)	MIS

cost per adjusted patient day (out and inpatient)	Financial	Wyatt (2004)	MIS
Inpatient outpatient revenues	Financial	Wyatt (2004)	MIS
margin per department	Financial	Wyatt (2004)	MIS
percentage of revenue from charitable sources	Financial	Wyatt (2004)	MIS
revenue and expense per physician	Financial	Wyatt (2004)	MIS
FTE's per adjusted occupied bed	Internal operations	Wyatt (2004)	MIS
admitting process performance	Internal operations	Wyatt (2004)	MIS
Average length of stay	Internal operations	Wyatt (2004)	MIS
Maintained bed occupancy	Internal operations	Wyatt (2004)	MIS
case mix index	Patient characteristics	Wyatt (2004)	MIS

Appendix M Underling Screenshoots

In this Appendix the underling information can be viewed. (confidential information)

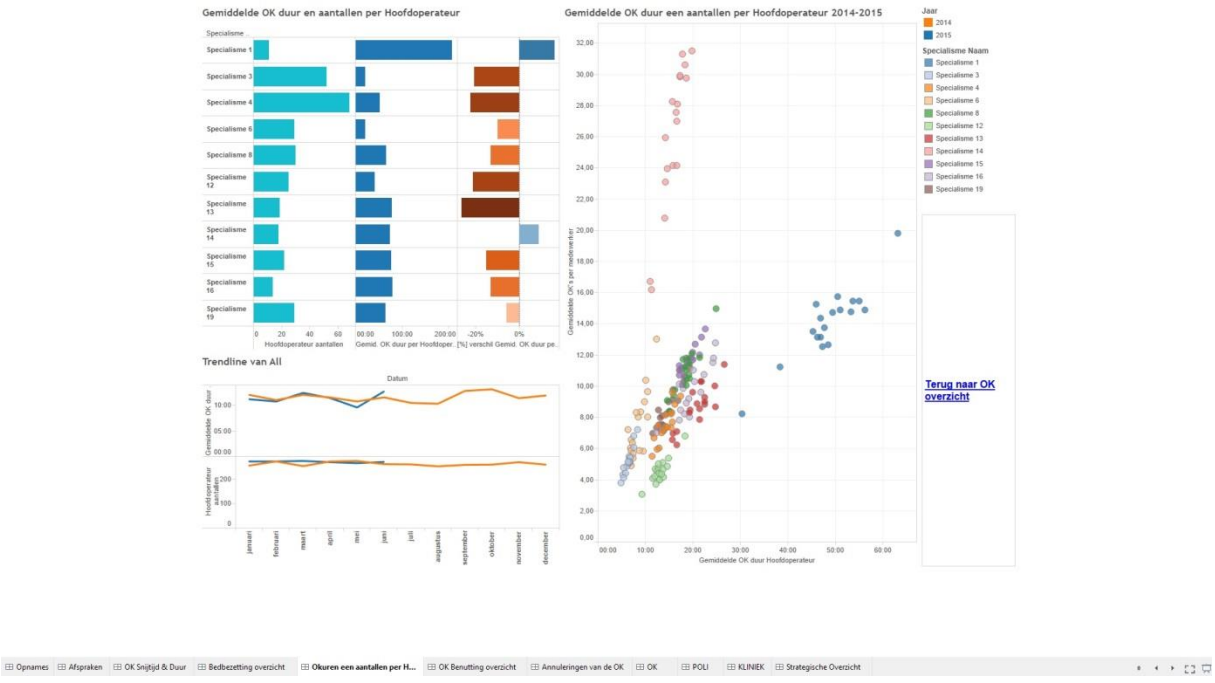
1. Outpatient Clinic Cancelation
2. Bed occupation
3. OR Cancelations
4. OR utilisation
5. Admissions
6. OR cutting time




Annuleringsreden OK
OkZittingAnnuleringRedenNaam (group)
Oorzaak onbekend
ziekenhuis annuleering
Patient annuleering
8.06%
20.04%
8.45%
-75.6%
85.5%
-57.0%
% of Total AantalZittingen
% Difference in AantalZittingen
Annuleringsreden per Specialisme
Specialisme Naam
OkZittingAnnuleringRed..
Oorzaak onbekend
ziekenhuis annuleering
Patiënt annuleering
Year of Datum, OkZitting..
Trend line anuleeringen Cardio-thoracale chirurgie, Chirurgie, Keel-, neus- en oorheelkunde and 15 more
Datum
AantalZittingen
2 nulls
Terug naar OK overzicht
Opnames
Afspraken
OK Snijtijd & Duur
Bedbezetting overzicht
Okuren een aantallen per Hoo...
OK Benutting overzicht
Annuleringen van de OK
OK
POLI
KLINIEK
Strategische Overzicht


Ok benutting Trend
Datum
Avg. Bruto OK-benutting % totaal
Avg. Uitloop %
OK benutting
Year of Datum
2014
2015
Difference in Avg. Bruto ..
Terug naar OK overzicht
Opnames
Afspraken
OK Snijtijd & Duur
Bedbezetting overzicht
Okuren een aantallen per Hoo...
OK Benutting overzicht
Annuleringen van de OK
OK
POLI
KLINIEK
Strategische Overzicht


Opnames overzicht & Dagopnames inzicht Radboudbreedt * (vergelijking tussen januari tot juni)
Opnames per Specialisme * / All
Opnames per Specialisme en All
Jaar
2014
2015
[%] Verschil
Terug naar Kliniek overzicht
Opnames
Afspraken
OK Snijtijd & Duur
Bedbezetting overzicht
Okuren een aantallen per Hoo...
OK Benutting overzicht
Annuleringen van de OK
OK
POLI
KLINIEK
Strategische Overzicht


Gemiddelde OK duur en aantallen per Hoofdoperateur
Gemiddelde OK duur een aantallen per Hoofdoperateur 2014-2015
Trendline van All
Jaar
2014
2015
Specialisme Naam
Terug naar OK overzicht
Opnames
Afspraken
OK Snijtijd & Duur
Bedbezetting overzicht
Okuren een aantallen per H...
OK Benutting overzicht
Annuleringen van de OK
OK
POLI
KLINIEK
Strategische Overzicht

Appendix N Guideline to use this research for other perspectives

In this part there are the steps described to advance this research to use it for the other three perspectives. This is not described in-depth because that was not the focus of this research. The four perspectives have different focuses, yet they should be balanced and interdependent (Nørreklit, 2000).

Steps to use this research for the other perspectives

1. Design construct: there is literature information, it could be easily used to identify the most important values of the three other perspectives
2. The strategic goals and actions are also defined which are related to the other perspectives
3. The outlining of the financial process, the patient satisfaction and the innovation can be done as well. Here is an example given for the financial perspective. (The most logical to develop next)
4. Example financial: what are the variable cost, wat are the fixed cost, how financial earning from research, financial earnings from education, financial earnings from research. Those can be more detailed
5. Brainstorm session for other perspectives can be repeated
6. The analysis of the available, recent values and the validation of those can be conducted in the same way.
7. The data can be gathered and there can be a prototype be generated by the tool Tableau.
8. The prototype can then again be used to validate the prototype, the interview questions then need alteration to fit the perspective

Limitations

To find the right values about patient satisfaction there patient should be included in the development, because they can give information about the importance values. Those information is harder to conduct, because of the different patients which visit the hospital. Companies are used to monitor the process and the finances and the customer/ patients. In the first perspective the innovation need to be monitored, this needs some out of the box thinking to be monitored well. It is possible that this perspective needs to be more remodel or changed than the others. Because innovative is the counterpart to standardisation.

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