Development of a Procedure Reference Model for the Alignment of Non-medical Support Service Applications in Hospitals – A Framework For Ensuring the Correct Reporting and Configuration of Key Performance Indicators

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Abbreviations

API	Application Programming Interfaces
ARIS	Architecture of Integrated Information Systems (German: Architektur integrierter Informationssysteme)
BA	Business Administration
BAG	Federal Office of Public Health (German: Bundesamt für Gesundheit)
BFS	Federal Office of Statistics (German: Bundesamt für Statistik)
BI	Business Intelligence
BPMN	Business Process Management Notation
CAFM	Computer Aided Facility Management
CEO	Chief Executive Officer
CHF	Swiss francs
COBIT	Control Objectives for Information and Related Technology
CIMOSA	Computer Integrated Manufacturing Open System Architecture
CSI	Continual Service Improvement
DIN	German Standard Institute (German: Deutsches Institut für Normung)
DRG	Diagnosis Related Groups
DSR	Design Science Research
DSS	Decision Support System
EAI	Enterprise Architecture Integration
EABPM	European Association Business Process Management
EFQM	European Foundation for Quality Management
EIS	Executive Information System
EPC	Event-driven Process Chain
ERD	Entity Relationship Diagram
ERM	Entity Relationship Model
ERMN	Entity Relationship-Model Notation
ERP	Enterprise Resource Planning
EU	European Union
FM	Facility Management
GEFMA	German Facility Management
HC	Healthcare
HIS	Hospital Information System
ICT	Information and Communication Technology
IDEF	Integrated Definition Language
IS	Information Systems
ISR	Information Systems Research
IT	Information Technology
ITIL	Information Technology Infrastructure Library
KPI	Key Performance Indicator
KVG	Health Insurance Act (German: Krankenversicherungsgesetz)
LekaS	Service Catalogue for Non-medical Support Services in Hospitals (German: Leistungskatalog für nicht-medizinische Supportleistungen in Spitälern)
LemoS	Service Allocation Model for Non-medical Support Services in Hosptials (German: Leistungszuordnungsmodell für nicht-medizinische Supportleis-tungen in Spitälern)

MSS	Management Support System
MIS	Management Information System
n.d.	no date
n.p.	no pagination
OECD	Organisation for Economic Co-operation and Development
OLAP	Online Analytical Processing
OMT	Object Modelling Technique
ORM	Object Role Modelling
PESTLE	Political, Economic, Socio-cultural, Technological, Legal, Ecological
PIF	Process Interchange Format
PRINCE	Projects in Controlled Environments
QUAL	Qualitative
QUAN	Quantitative
RAD	Role Activity Diagram
SCOR	Supply-Chain-Operations-Reference-Modell
SIPOC	Supplier/Input/Process/Output/Customer systems diagrams
SOA	Service Oriented Architecture
SOM	Semantic Object Model
SSAGK	Swiss SAP Usergroup in Hospitals (German: Schweizerische SAP Anwendergruppe Krankenhaus)
TARMED	Medical Tariff (French: tarif medical)
UML	Unified Modeling Language
XML	Extensible Markup Language
XPDL	XML Process Definition Language
YAWL	Yet Another Workflow Language

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The value of achievement lies in the achieving.

- Albert Einstein -

Abstract

The outcome of this thesis is the systematically developed and empirically validated “Procedure Reference Model for the Alignment of Non-medical Support Service Applications in Hospitals” comprising six component models, the metamodel, two input documents and a documentation for application as integral parts. The development of the model was done based on a pragmatic philosophical grounding in a multi-methodological iterative approach, including Design Science Research (DSR) principles for the modelling actions and mixed methods principles for the empirical research. In the “Theorising” phase, a sequential mixed methods approach combining a quantitative survey with qualitative expert interviews was conducted generating the basis for the modelling. In two iterations of the “Building” phase, the modelling actions were conducted. While in the “Evaluating” phase, the model was validated in two iterations based on expert interviews and focus group discussions. The model turned out to be relevant in the context of the challenges posed by the current structural changes in healthcare and hospitals. As part of these changes, non-medical support services are increasingly seen as essential not only in contributing to a better cost-efficiency but also as service enabler for the medical services. To be able to deliver the adequate services and service levels and control them within the very complex service provision of hospitals, the managers depend on relevant key performance indicators (KPIs) in an appropriate reporting setting. In Swiss hospitals, the configuration of KPI reporting had only partially been aligned in terms of software applications and/or in terms of reporting styles. Therefore, the research aims and objectives of this thesis were to find a procedure and its significant aspects for aligning non-medical-support service applications in hospitals so that in the future, relevant key performance indicators for systematic controlling and optimization can be generated and configured as effectively and efficiently as possible including the development of a model providing the necessary information. The evaluation of the model showed that the research output was credible and contributory. For practice, it provides a systematic basis for communication between different non-medical support service application stakeholders and thus enables managers to indirectly contribute to the development of a more effective healthcare provision. For the scientific community, it contributes to the development of multi-methodological DSR approaches suitable for complex environments and for multi-disciplinary environments.

Keywords: Healthcare, Hospital, Non-medical Support Services, Key Performance Indicators, Software Application, Conceptual Modeling, Reference Modelling, FM in Healthcare

1 Introduction

The structure of this thesis is set up as follows:
As an introduction, in chapter 1, the

- research background
- research domain
- research problem

are set out as the basis for the

- formulation of the research question and
- research aim and objectives.

In addition, the

- research gaps are presented
- contribution to innovation is discussed and
- delimitations

are outlined.

In chapter 2, the conceptual fundamentals of the research context are explained in detail. They include the topics of

- healthcare and hospitals
- the service differentiation in Business and Management Research and hospital management
- Information and Communication Technology (ICT), information and application systems in general and specifically within hospitals as well as Information Systems Research (ISR) as a discipline
- key performance indicators (KPIs) and their reporting, both in general and within hospitals
- stakeholders and stakeholder management in general, in hospitals as well as in the context of information systems in hospitals
- conceptual models in general, in specific contexts and of different types

In chapter 3, the research methodology is explained, namely the

- scientific position and philosophical grounding including the explication of the basic belief, the ontology, the epistemology, the concept of truth and the axiology
- methodological position comprising the research approaches, the research strategy, the research timeframe, the data collection approaches, the data analysis approaches and the artefact construction
- derivation of the research design
- applied quality criteria framework

Chapter 4 contains the explication of the research conducted:

- data collection and analysis in the "Theorising" phase
- modelling and re-modelling procedure in the "Building" phase
- data collection and analysis in the "Evaluating" phase

Chapter 5 includes the

- conclusions drawn

- critical reflections
- research limitations
- recommendations
- outlook

This chapter's location in the overall context is illustrated in Figure 1.

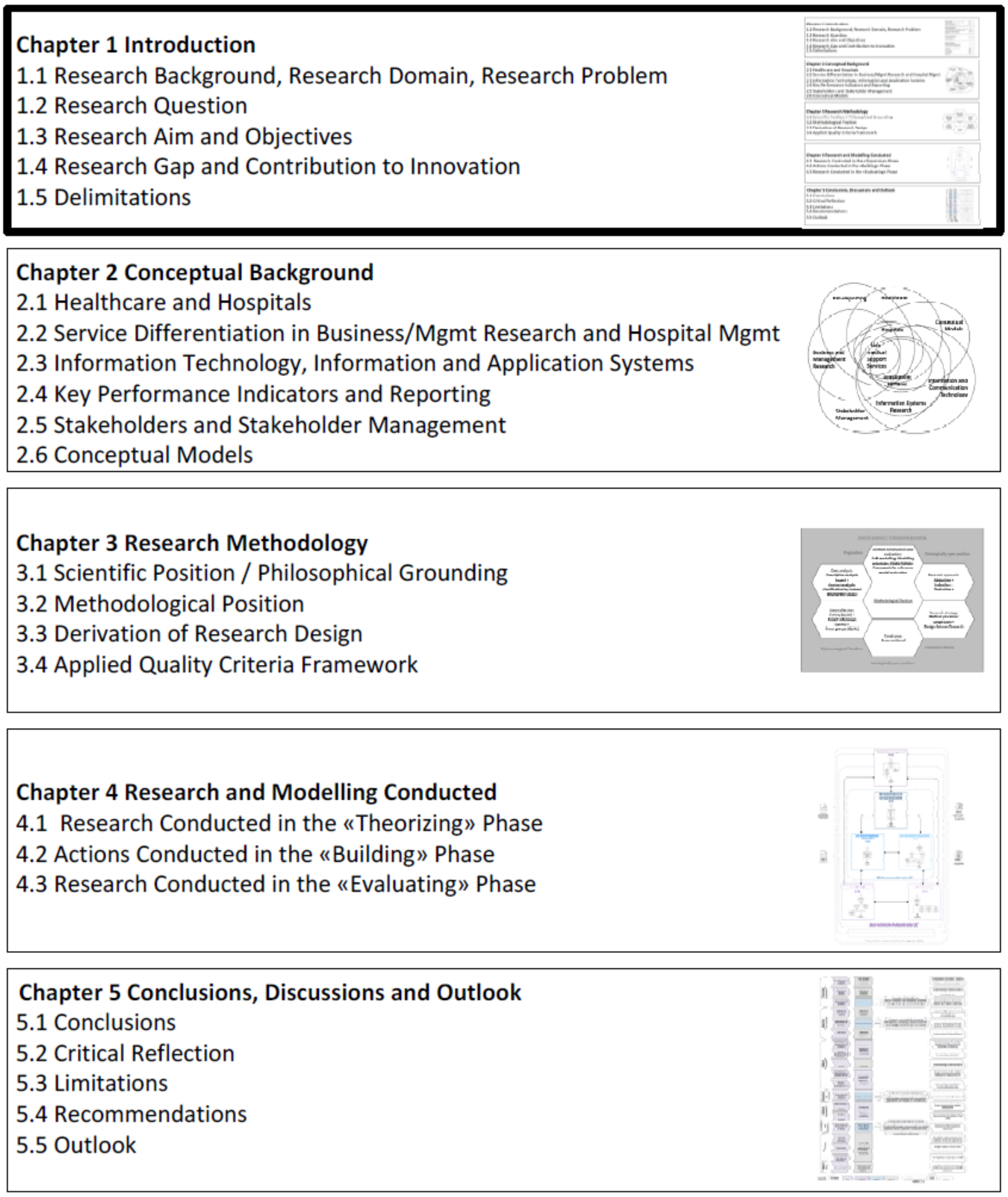

Figure 1: Location of chapter 1 in the overall context

1.1 Research Background, Research Domain and Research Problem

In this section, the research background is briefly summarised in order to explain the research problem and to outline the research domain. The detailed context of the mentioned research background topics will be presented in chapter 2.

1.1.1 Overview of the Research Background

Healthcare in Western European countries is facing many different and complex social, technological, political and economic challenges. The most important ones are

- aging populations
- fast medical and medical-technical progress
- growing complexity in the medical treatment process
- social change of values
- skills shortage
- new financing processes

requiring, amongst others, more

- interdisciplinary competences by the people involved
- quality assurance
- transparency
- patient orientation

leading on one hand to an increase in health care expenditure and competition while on the other side resources for healthcare become more limited (Bornewasser, 2013; Braun von Reinersdorff, 2007; Busse, et al., 2009; Busse & Geissler, 2017; Classen, 2009; Haubrock, 2009; Haubrock, 2018f; Henke, et al., 2011; Hess, 2014; Klaus, 2012; Knoth, et al., 2012; Kriegel, 2012; Lafortune, et al., 2012; Lohmann, 2009; Madritsch, 2009; Marsolek & Friesdorf, 2009; Oggier, 2015; Thiede, 2017; van Rooijen, et al., 2013; Wasem, 2017). Hospitals using up roughly three quarters of the total expenditure for healthcare in Switzerland (BAG Bundesamt für Gesundheit, 2018) are specifically affected by this situation. According to Angerer et al. (2012), Busse et al. (2009), Kriegel (2012), Rohner (2013) Sonntag (2017) and Thiede (2017) one of the most important challenges is how to cope with the cost pressure and consequently the need for more efficiency, transparency and interdisciplinary cooperation.

The non-medical support services in hospitals are part of the general discipline of Business and Management Research and comprise, according to Gerber (2016), the area of Logistics, Infrastructure, Facility Services and Hospitality. Providing the corresponding services accounts for up to a third of the costs in a hospital (Abel & Lennerts, 2006). As these areas mostly do not or only indirectly generate income, they are under particular pressure to raise productivity while assuring quality as well as patient and staff satisfaction (Bornewasser, 2013; Hizgilov & Redlein, 2011; Kriegel, 2012; Salfeld, et al., 2009). In order to effectively control and manage the provision of non-medical support services, managers in these areas need – as managers in other areas and industries – an adequate reporting of the relevant KPIs as well as a systematic approach to stakeholder management.

The data necessary to calculate KPIs has to be provided through the information system of an organisation. Information systems in hospitals are very complex with numerous legacy systems and several technical and human challenges (Behrendt, 2009; Furter, 2016; Gocke, 2006; Jobst & Pelikan, 1995; Niemann, et al., 2002; Raphael, 2013; Schweiger, 2007) influencing the way ICT services – like delivering data for KPI calculation – can be provided. In Information Systems Research, conceptual models are suggested to be applied for reducing complexity and as a basis to foster a common understanding for discussions (Banks & Nelson, 2014; Bernard, et al., 2017; DIN, 2000; EABPM, 2014; Goeken, 2003; Grochla, 1974; Joosten, 2000; Kruse, 1996; Müller & Johner, 2009; Pidd, 2009; Prilla, 2010; Storey & Thalheim, 2017) and reference models in particular to have best practices for a certain domain (DIN, 2000; Fettke & Loos, 2003b; Fettke & Loos, 2006; Fettke &

Loos, 2007; Frank, 2007a; Frank, et al., 2007; Scheer & Nüttgens, 2000; Seubert, 1997; Winter, et al., n.d.; Winter & Schelp, 2006).

This thesis is allocated in the context of hospitals as part of healthcare provision. The main focus lies on the key performance indicator reporting of non-medical support services as part of Business and Management Research, being dependent on Information and Communication Technology, particularly application systems, as part of Information Systems Research, using conceptual models and stakeholder management principles. The context is schematically illustrated in Figure 2. The necessary definitions, the bases and the state of the art literature for the mentioned topics are individually presented in detail in chapter 2.

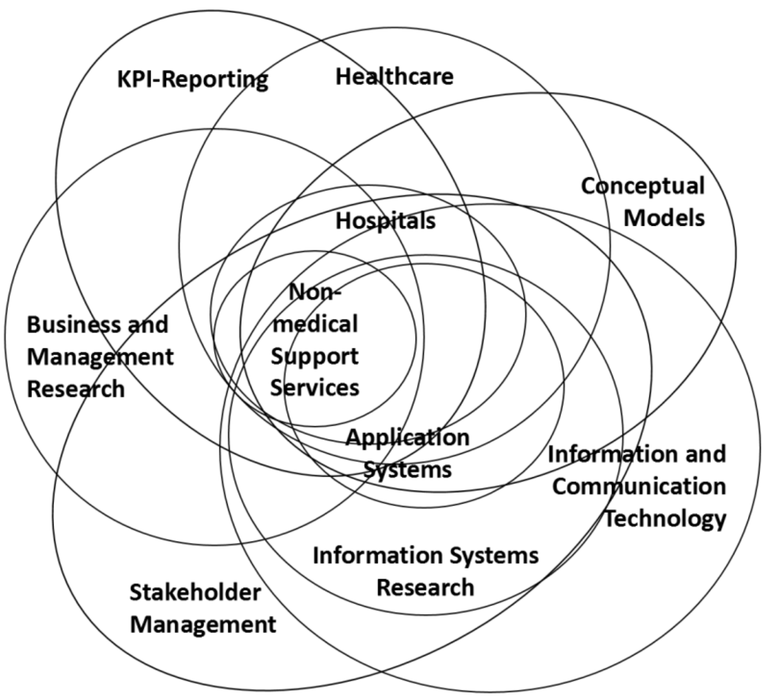

Figure 2: Illustration of research background scope of this thesis based on Gerber (2018)

1.1.2 Research Domain

The research domain of the subject matter under study in this thesis are software applications of the non-medical support services in Swiss hospitals.

In this thesis, the following definitions about the research domain of the subject matter are chosen as a basis:

Hospitals are, according to the WHO World Health Organisation *(n.d., n.p.)*, […] "health care institutions that have an organized medical and other professional staff, and inpatient facilities, and deliver medical, nursing and related services 24 hours per day, 7 days per week". For details about healthcare and hospitals cf. section 2.1.

Non-medical support services comprise, based on Gerber (2016) and illustrated in Figure 3, Logistics (Procurement, Inventory Management, Transport & Distribution, Disposal & Recycling), Infrastructure (Maintenance, Space Management, Energy), Facility Services (Safety, Security, Cleaning, Sterilisation) and Hotel Services (Catering, Textiles, Accommodation Administration & Operation of Properties, Hotel Various).

Non-medical support services in hospitals and Facility Management in Healthcare (FM in HC) are used synonymously. For details about the non-medical support services cf. section 2.2.

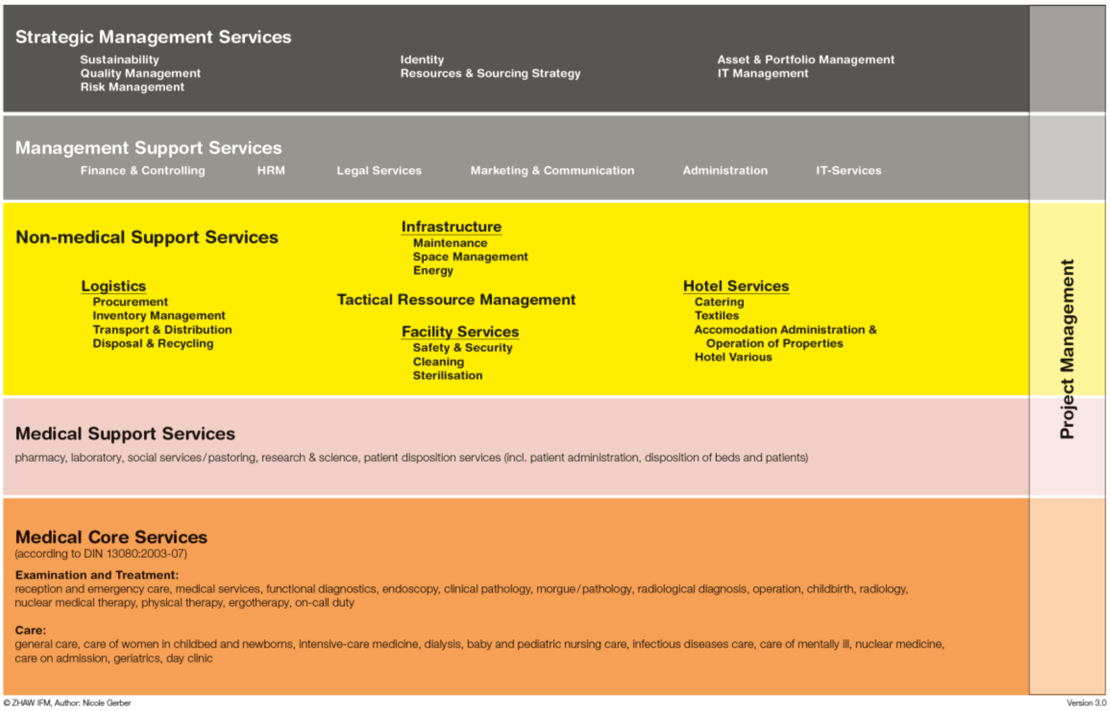

Figure 3: Definition of non-medical support services according to Gerber (2016)

Software applications are, according to Stahlknecht (2001), any software which offer the functionalities to support business processes and data management. For details about applications cf. section 2.3.

1.1.3 Research Problem

As Gerber (2014b), Gerber and Perschel (2016), Gerber et al. (2016) and Gerber et al. (2017c) have shown, applications in non-medical support services have in the past not been paid particular attention to in terms of alignment, both amongst each other and on the overall software architecture of the hospital. In addition, information systems in hospitals are currently mostly very fragmented due to the fact that in the past

- no holistic view or alignment efforts were undertaken between the different disciplines
- rather little investment was made in this context
- reference models or approaches for information systems alignment in healthcare – where available – mostly comprise only specific and mostly medical areas, not taking into account the totality and interconnectedness of the overall delivered services in a hospital

(Haas, 2009; Kipperhardt, et al., 2006; Kleemann, 2010; Lagasse, 2018; Simoneit, 1998).

The description of this thesis' research problem is based on a statement of Walser et al. (2013, p. 11): "Finally, the statements on information management indicate that the operating structures and processes at the hospitals should be viewed in more detail and possibly partially revised; this is because reliable performance management is only possible when the required data for the entire hospital can be collated and compared. There is thus a need for further investigation into the organisational challenges of performance management in Swiss hospitals." This statement indicates that the top management of hospitals doesn't fully understand the importance of information management and the support services. For details about application alignment and integration in hospitals cf. subsection 2.3.4.3.2.

1.2 Research Question

The research question of this thesis is based on the research problem.

The research question of this thesis is: What is the procedure and its significant aspects for aligning non-medical-support service applications in hospitals so that relevant key performance indicators for a systematic controlling and optimization can be generated and configured as effectively and efficiently as possible?

1.3 Research Aim and Objectives

In this section, the research aim and objectives are outlined.

1.3.1 Research Aim

The research aim depends on the research question.

The research aim of this thesis is defined as: To develop a reference model providing the necessary information about a standardized procedure and its significant aspects for aligning non-medical support service applications in hospitals so that relevant key performance indicators for systematic controlling and optimization can be generated and configured as a decision basis for managers. The systematic and holistic development of the reference model is supposed to serve as a fundamental basis for the understanding of the importance of the context on all management levels.

1.3.2 Research Objectives

As this thesis is following the Design Science Research principles (cf. subsection 3.2.2.2), the research objectives include both epistemic and design objectives.

1.3.2.1 Epistemic Objectives

The epistemic objective is concerned with the understanding of a context, situation or problem (Becker, et al., 2003; Riege, et al., 2009).

In this thesis, the epistemic objective is to develop a relevant and economically efficient artefact according to Anderson et al. (2012), Becker et al. (2000), Becker et al. (2012), Benbasat and Zmud (1999), DIN (2000), Martensson and Martensson (2007), Rautenstrauch and Schulze (2003), Rosemann (1996) and Schütte (1998). Details about the corresponding principles cf. subsection 3.2.6.4.

1.3.2.2 Design Objectives

The design objective deals with the development of a solution (Becker, et al., 2003; Riege, et al., 2009).

In this thesis, the design objective is to develop a an artefact, which is (formally) correct, has a systematic design, is clear and comparable, has an adequate construction and language according to Becker et al. (2000), Becker et al. (2012), Benbasat and Zmud (1999), DIN (2000), Frank (2000a), Frank (2007a), Fettke (2009), Herrler (2007), Martensson and Martensson (2007), Rautenstrauch and Schulze (2003), Rosemann (1996), Schalles et al. (n.d.) and Schütte (1998). Details about the corresponding principles cf. subsection 3.2.6.4.

1.4 Research Gap and Contribution to Innovation

As discussed in section 1.1, there is not one, but several research gaps in the outlined context:

- As many other industries and the medical core business in hospitals, the non-medical support services are more and more dependent on suitable software applications in order to overcome the increasing complexity and interdisciplinary requirements. Due to the fact that the non-medical support services in general and their software applications in particular have just about started to be acknowledged as an important contribution for the hospital business success, no robust data for a systematic development is available.
- Several attempts have been undertaken to investigate the alignment and integration of information systems in hospitals, the focus so far has however mostly been on the medical software; the non-medical support services were usually subsumed within general administration and not as stand-alone discipline or they have only been looked at on a general as-is inventory basis. An encompassing and systematic approach for aligning non-medical support service applications in hospitals with the aim to enable an adequate configuration and reporting of relevant key performance indicators for a systematic controlling and service optimization is missing.
- The explicit combination of research approaches from Information Systems Research and Business Research, namely the Design Science Research principles (cf. subsection 3.2.2.2) and empirical mixed methods (cf. subsection 3.2.2.1) particularly in the healthcare context is new.

1.5 Delimitations

This thesis explicitly does not cover the following topics

- the medical area (E-Health, medical applications, medical data, patient data etc.)
- (medical) Hospital Information Systems (HIS); they are only included in terms of interfaces with non-medical support service applications or data, not as medical applications per se
- any cost and financing aspects (prices of applications, cost distribution, hospital financing etc.)
- specific software products or providers
- data security or data protection aspects (cyber security etc.)
- technical implementation of applications
- the context of systems software
- simulation of scenarios based on KPIs
- benchmarking of KPIs

Due to language barriers, only German-speaking Swiss hospitals were included in the investigation.

2 Conceptual Background

This chapter will provide the necessary conceptual basis outlining the context of the research background, research domain and research problem including the subjects healthcare and hospitals, business research, management research and hospital management, information and communication technology (ICT) and application systems in general and in hospitals, key performance indicators (KPIs) and reporting in general and in hospitals, stakeholder management in general and in hospitals as well as models. In Figure 4, the context of chapter 2 within the whole thesis' structure is illustrated.

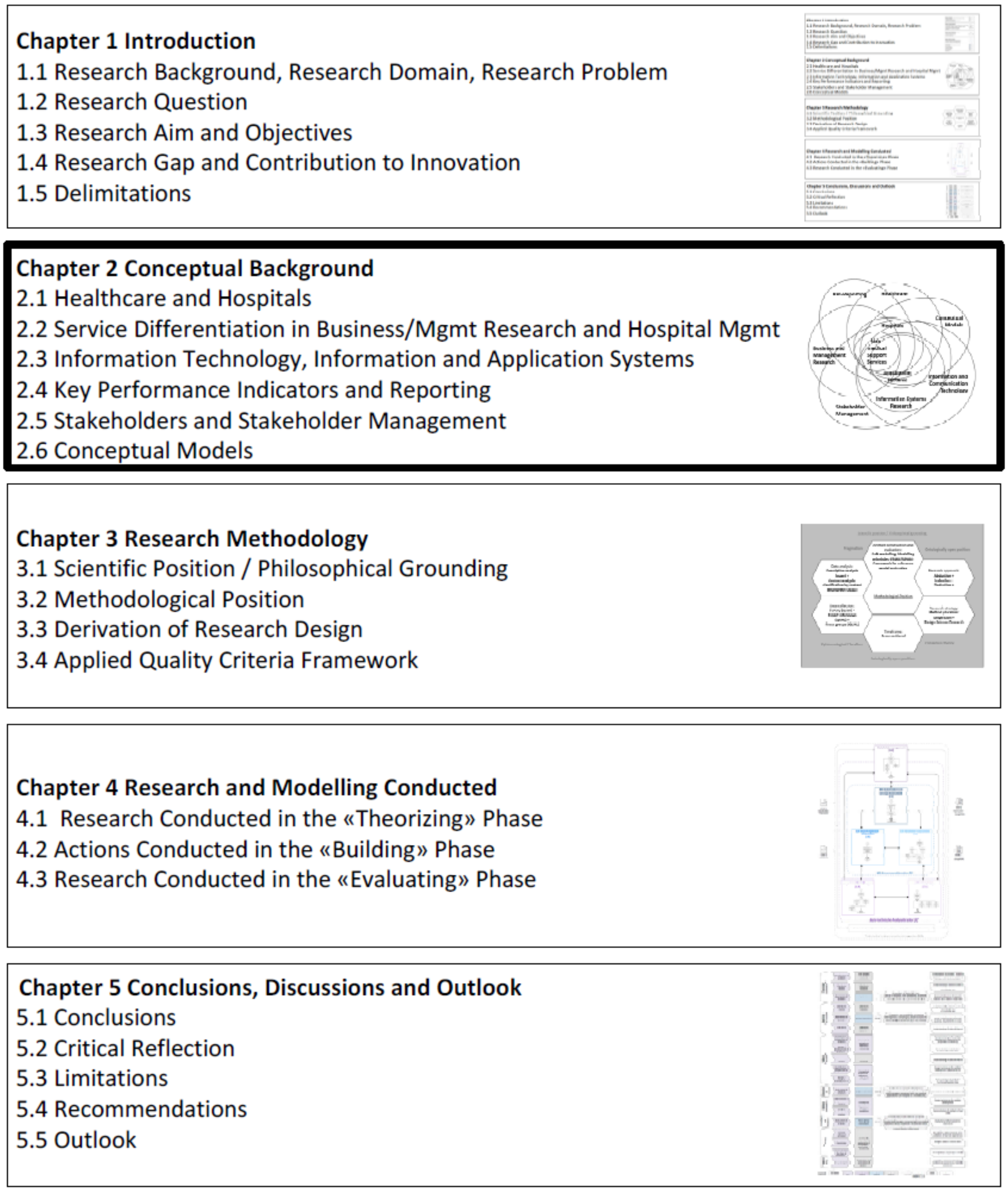

Figure 4: Context of chapter 2 within the whole thesis

2.1 Healthcare and Hospitals

In this section, the healthcare context and the situation of hospitals in general and in Switzerland in particular are presented. In Figure 5 the topic is schematically illustrated in the context of the conceptual basis.

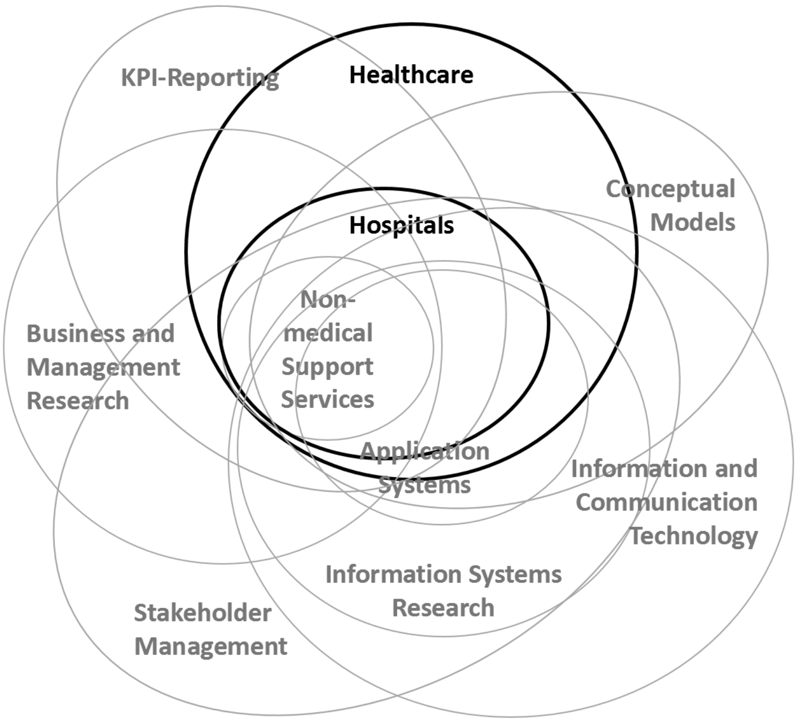

Figure 5: Healthcare and Hospitals as parts of the conceptual background chapter in this thesis based on Gerber (2018)

2.1.1 Healthcare

To start with, an introduction to the definition and context of healthcare is given, both in general and specifically for Switzerland.

2.1.1.1 Healthcare – A General Introduction

The World Healthcare Organisation WHO (2006, p. 1) declares that "Governments have a responsibility for the health of their peoples which can be fulfilled only by the provision of adequate health and social measures." In order to fulfil this task, every government as one of the major cost bearers tries to regulate and finance the provision of health services via health professionals for the patients to a certain degree. Because of this specific setup, a special situation regulating the demand and a limitation of the free market exists, with professional and industry lobbyists trying to influence the actions (Camenzind, 2016). The fact that specifically the developed Western countries including Switzerland are continuing their transformation from industrial nations to service societies, the qualitative and quantitative expansion in the healthcare sector is still progressing, driven by the corresponding change of societal values leading to increasing patient and quality requirements accompanied by an aging society (Busse, et al., 2009; Busse & Geissler, 2017; Classen, 2009;

Haubrock, 2009; Haubrock, 2018f; Hess, 2014; Klaus, 2012; Knoth, et al., 2012; Kriegel, 2012; Marsolek & Friesdorf, 2009; Oggier, 2015). At the same time all these factors

- demographic change
- skill shortage in healthcare professions
- increasing complexity
- incremental innovation in medicine and healthcare related technology
- the development of the wellness market
- internationalization / globalization of the healthcare market
- inter-professional / multi-disciplinary / inter-sectoral cooperation in healthcare service provision
- strategic healthcare market segmentation
- competitive financing concepts of hospitals and
- sensitisation about health and increasing healthcare demand by people / patients

influence the healthcare sector (Busse, et al., 2009; Busse & Geissler, 2017; Braun von Reinersdorff, 2007; Classen, 2009; Haubrock, 2018f; Hess, 2014; Knoth, et al., 2012; Kriegel, 2012; Lohmann, 2009; Wasem, 2017). This leads to increasing healthcare cost – 12 OECD countries spend more than 10 % of their GDP on healthcare (Rutz, et al., 2018) while at the same time, governments have less public funds available (Busse & Geissler, 2017; Haubrock, 2018f; Lohmann, 2009; Madritsch, 2009; van Rooijen, et al., 2013; Rutz, et al., 2018). In order to deal with the situation, governments try to take political measures to increase productivity and/or to reduce costs in healthcare (Bornewasser, 2013; Busse, et al., 2009; Kriegel, 2012). Cost pressure leads to

- more competition
- more benchmarking
- more efficiency however still guaranteeing a certain quality level
- more transparency and
- innovative and cooperative ideas for service provision

(Braun von Reinersdorff, 2007; Hess, 2014; Henke, et al., 2011; Kriegel, 2012; Lohmann, 2009; Madritsch, 2009; Marsolek & Friesdorf, 2009).

To deal with these challenges, the healthcare sector is advised to use the information and communication technology to support and optimize the processes – as other industries have done (Hess, 2014; Lohmann, 2009; Marsolek & Friesdorf, 2009). Should it not be possible to meet the challenge, van Rooijen et al. (2013, p. 3) see the potential that this will “harm solidarity and social cohesion”.

2.1.1.2 Healthcare in Switzerland

In Switzerland, the healthcare sector is highly decentralized on federal, cantonal and communal levels, while the 26 sovereign cantons play a critical role by individually deciding on licensing the providers and subsidizing organisations and institutions (Camenzind, 2016). In the past, cost was not the major concern of the Swiss healthcare sector, leading to a triplication of health care cost between 1985 and 2012 (Oggier, 2015) or a nominal increase by a factor of 40 between the 1960s and 2015 from roughly 2 billion to 77,7 billion Swiss francs (CHF) which equals CHF 782 per person per month (Cosandey, et al., 2018, pp. 9-12). This signifies a healthcare cost increase from less than 5% of the gross domestic product in the 1960s to more than 11% in 2015 (BFS Bundesamt für Statistik, 2016; Cosandey, et al., 2018). Experts estimate that the healthcare cost will continue to increase by a higher degree than other public expenditure (Rutz, et al., 2018). In general it can be said that healthcare in Switzerland is of high quality and enjoying a very high acceptance by the Swiss population (Fosco, 2017), albeit at a very high price, ranked the second most expensive healthcare country world-wide behind the USA (Camenzind, 2016; Kriegel, 2012). While Credit Suisse (2013) forecasts that the demand and the offer for healthcare will continue to increase, more political measures have to be implemented in order to contain costs while still guaranteeing high-quality healthcare and keeping the solidarity among the insured. In 2012, the Swiss Health Insurance Act was revised, inducing regulated competition among health insurers and service providers (Camenzind, 2016), triggering a consolidation of the market (Credit Suisse, 2013). Further measures within the "Health2020" program are continuously debated (Camenzind, 2016; Oggier, 2015). By these developments, the Swiss healthcare sector will have to meet the same challenges as other Western countries described in subsection 2.1.1.1.

2.1.2 Hospitals

In this subsection, the specific context of hospitals within the healthcare industry is presented, both in general and particularly for the Swiss context.

2.1.2.1 Hospitals – Starting Position and Overall Challenges

In the endeavour to provide health to people, hospitals are currently the largest single component within OECD and EU countries (Kriegel, 2012; Lafortune, et al., 2012; Rutz, et al., 2018). In medieval times, hospitals were lodgings for old, sick and poor people as well as orphans, mainly run by clerical and monastic institutions (Fritsche & Hermann, 2009). The current understanding of hospitals started in the 18th century (Fritsche & Hermann, 2009; Kutter, 2016). According to WHO (n.d., n.p.)

> Hospitals play an important role in the health care system. They are health care institutions that have an organized medical and other professional staff, and inpatient facilities, and deliver medical, nursing and related services 24 hours per day, 7 days per week. Hospitals offer a varying range of acute, convalescent and terminal care using diagnostic and curative services in response to acute and chronic conditions arising from diseases as well as injuries and genetic anomalies. In doing so they generate essential information for research, education and management.

A hospital is thus a service company with the goal to transform the health status of a patient from ill to eased or healthy as well as providing birth assistance according to given regulations (Bornewasser, 2013; Eichhorn, 2008b) by the means of different in-patient or ambulatory medical, diagnostic, therapeutic and care services, adequately using the corresponding various kinds of material and non-material resources (Eichhorn, 2008b; Lafortune, et al., 2012). Depending on the context, research and development can also be an assignment of a hospital (Eichhorn, 2008b; Flessa, 2014). According to Flessa (2014) hospitals can be differentiated by varying criteria such as by the size, the intensity of treatment and care, the medical staffing, the duration of stay or the trusteeship.

According to Felder (2016), Eichhorn (2008b), Flessa (2014), Fritsche and Hermann (2009), Roeder and Bunzenmeier (2017), Salfeld et al. (2009), Schult (n.d.) and Walther (2005), the service provision of hospitals is characterized by several challenges:

- On a metaphysical level, human health and human lives are not only a very individual, but also a social asset of society and thus very hard to be quantified and measured.
- The act of providing health to humans in a hospital is very complex and highly interdependent on different disciplines which leads to a high need of coordination between different stakeholders.
- The provision of the complex and individual medical services is characterized by the need for an intense involvement of qualified personnel with a high potential for influence, requiring the presence

of the patient (uno-actu principle) as well as a relationship of trust between the medical staff and the patient, even more as the patient is often not capable of deciding about the medical service needed.

- In terms of national economics, there are high fixed costs with a low supply-side flexibility.
- Legally, there are several special regulations to be followed.
- Having to deal with all the different challenges at once poses another challenge in itself.

2.1.2.2 Development of Hospitals in the Past

The special circumstances described above have led to specific developments in the service provision of health within hospitals in the past (Angerer, et al., 2012; Borzekowski, 2002; Braun von Reinersdorff & Rasche, 2014; Engelke, 2008a; Fischlein & Pfänder, 2008; Harris, 1977; Johner, 2016; Kriegel, 2012; Lagasse, 2018; Salfeld, et al., 2009; Walther, 2005):

- The absolute focus was to provide medical services which triggered that individual medical eminent authorities and their reputation were the main concern.
- A strong autonomy and tendency of differentiation of the medical experts or disciplines led to the constitution of individually defended kingdoms, missing internal and external linkages, inadequate organisational structures, an increased bureaucracy, missing synergy utilization, information silos and differing worlds of thinking and languages within one hospital.
- Economical thoughts and thus prosperity of the whole hospital as an enterprise and/or an open error culture were not common.
- The result was the fact that there was no market and thus a missing business orientation leading to very little transparency in numbers and information, little standardization and thus an inconsistent understanding of quality and success.

2.1.2.3 Current Challenges of Hospitals

Healthcare undergoing a big economic, political and societal change (cf. subsection 2.1.1) puts big pressure on the hospitals to overcome several main challenges not only as the biggest cost block in healthcare but also as one of the most important providers of high quality health services to people; hospitals are therefore forced to

- undergo economization encompassing enterprises ensuring the capability of re-investments (analogous to other industries about 30 years ago) (Behrendt, 2009; Braun von Reinersdorff, 2007; Braun von Reinersdorff & Rasche, 2014; Bornewasser, 2013; Busse, et al., 2009; Busse & Geissler, 2017; Fischlein & Pfänder, 2008; Gerber, 2014; Knoth, et al., 2012; Korff, 2012; Kriegel, 2012; Lafortune, et al., 2012; Lennerts, et al., 2003; Rasche, et al., 2010; Richter & Götz, 2013; Richter & Götz, 2013; Richter & Götz, 2013; Roeder & Bunzenmeier, 2017; Wibbeling & Hintze, 2018)
- take a process orientation and optimization, triggering the need for a new organisation and management understanding and thus the need for change management (Angerer, et al., 2012; Cleven, et al., 2016; Fischlein & Pfänder, 2008; Müller & Johner, 2009; Rasche, et al., 2010; Roeder & Bunzenmeier, 2017; Salfeld, et al., 2009; Salfeld, et al., 2009; Walther, 2005)
- introduce encompassing controlling in order to enable performance, resource and quality management and thus internal and external benchmarking (Bornewasser, 2013; Busse, et al., 2009; Busse & Geissler, 2017; Kipperhardt, et al., 2006; Roeder & Bunzenmeier, 2017; Salfeld, et al., 2009; Sonntag, 2017; Thiede, 2017; Thiex-Kreye, 2009; Walser, et al., 2013)

- embrace interdisciplinary exchange across all the different professions, disciplines and institutions (Braun von Reinersdorff, 2007; Korff, 2012; Kriegel, 2012; Kutter, 2016; Roeder & Bunzenmeier, 2017; Salfeld, et al., 2009)
- implement more information and communication technology (Braun von Reinersdorff, 2007; Burwitz, et al., 2013; conhIT, 2013; Dannemaier, et al., 2009; Heng, 2016; Köbler, et al., 2010; Prabha & Belokrinitsky, 2014; Rasche, et al., 2010)
- develop measures to overcome the staff shortage (Busse & Geissler, 2017; Knoth, et al., 2012; Korff, 2012; Wibbeling & Hintze, 2018)
- renew the infrastructure (Salfeld, et al., 2009)

The biggest challenge most likely lies within the fact that hospitals have to handle all the mentioned changes simultaneously or at least prioritize them while continuously providing health services 365 days 7 days per week, 24 hours a day (Braun von Reinersdorff, 2007; Fischlein & Pfänder, 2008; Kriegel, 2012; Roeder & Bunzenmeier, 2017; Salfeld, et al., 2009).

It becomes clear that hospitals are facing challenging times, involving all the different service provision levels and stakeholders. However, it should not be forgotten that with all these endeavours, the main goal should be that in the end, every patient should profit in receiving high quality, but affordable health services in hospitals.

2.1.2.4 Trends for Hospitals in General

For (Western) hospitals, the following trends are expected:

- Increasing patient focus / patient centred process thinking: The service provision will be more patient needs oriented, including new non-medical service offers like shopping, sports, journals, culture, child-care etc. (Braun von Reinersdorff, 2007; Fischer, 2017; Kipperhardt, et al., 2006; Kriegel, 2012; Roeder & Bunzenmeier, 2017; Salfeld, et al., 2009; Wibbeling & Hintze, 2018).
- More intense inter-professional / multi-disciplinary / inter-sectoral cooperation for the service provision and/or mergers and acquisitions: With the goal to cover the needs within a patient-oriented process, cooperation and using synergies based on competences instead of hierarchies will be implemented with a possible new role of a process owner for the entire patient process (Braun von Reinersdorff, 2007; Knoth, et al., 2012; Kriegel, 2012; Roeder & Bunzenmeier, 2017; Salfeld, et al., 2009).
- More political deregulation accompanied by the need for economization and customer and stakeholder thinking: There will be a strive for medical and non-medical operational excellency including more outsourcing of underutilized or unprofitable areas and thus the need for more key performance indicators as a basis for decision (Braun von Reinersdorff, 2007; Engelke, 2008a; Kirstein & Schmitz, 2006; Korff, 2012; Kriegel, 2012; Salfeld, et al., 2009; Sonntag, 2017; Thiede, 2017).
- Intensified internationalisation and globalisation of the healthcare market (Braun von Reinersdorff, 2007; Kriegel, 2012).
- Further digitalisation and technologisation: This trend includes shared applications on private mobile phones, more available medical and service data and thus enhanced communication between the patients and the staff as well as improved possibilities for quality evaluation, surveillance and to bridge waiting times (Braun von Reinersdorff, 2007; Fischer, 2017; Lohmann, 2009; Mentges, 2006; Wibbeling & Hintze, 2018).

- Need for further cultural changes: Changes in culture mean more risk management instead of finger pointing (Utler, 2006), more focus on change management (e. g. holistic thinking, visions, interactive project culture, development of new competencies), more transparency in communication as well as staff motivation initiatives (Eichhorn, 2008a; Knoth, et al., 2012; Korff, 2012; Roeder & Bunzenmeier, 2017).
- Requirement for the development of new staffing strategies, employment models and professional development: Aiming at overcoming staff shortage, the development of new professions with corresponding training and new work time models in order to enable the compatibility of working and private time will be implemented (Busse & Geissler, 2017; Knoth, et al., 2012; Korff, 2012; Wibbeling & Hintze, 2018).
- Balance between change and stability: Hospital Managements will increasingly have to find a balance between change and innovation and stabilization and knowledge protection (Eichhorn, 2008b; Knoth, et al., 2012).

2.1.2.5 Hospitals in Switzerland

This subsection focuses on the specific context of Swiss hospitals in the past, the present and the future.

2.1.2.5.1 Developments within the Swiss Hospital Landscape in the Past and at Present

Fritsche and Hermann (2009) show that in Switzerland, the formation of the cantonal hospital of Zurich 1836 started an intense development of public and private hospitals influencing each other during the expansion ever since. After 1970, the hospital landscape of Switzerland has been developing, leading to a doubling of the number of hospitals between 1970 and 1982, followed by a reduction in the number particularly of public hospitals due to closures and conversions up until now (Berger, et al., 2015). Between 2000 and 2012, the number of hospitalisations increased by 22 % while the number of patient-days dropped by 10 % (Berger, et al., 2015, p. 398).

According to the Swiss Federal Statistical Office (BFS Bundesamt für Statistik, n.d.), in 2016, there were 283 hospitals in Switzerland with 102 being general hospitals (centrum and primary care) and 181 special clinics (psychiatric institutions, rehabilitation/geriatrics, others) on 569 sites. According to the Swiss Federal Office of Public Health (BAG Bundesamt für Gesundheit, 2018, p. 5) in 2016, these entities provided a total of 38,059 beds and treated 1,442,140 inpatient cases with 161,945 employed full time equivalents.

In terms of ownership, the Swiss hospitals can be divided into three categories (Berger, et al., 2015; Felder, 2016):

- private clinics: private law organisations with mainly private ownership
- public hospitals: governmental ownership
- subsidized entities

Since 2007, there has been a tendency towards more private hospitals (Berger, et al., 2015). Differentiation between the public and private hospitals and their legal structures is not always unambiguous which however has lost importance since the revision of the health insurance law (KVG). In an international comparison provided by Felder (2016), Switzerland has rather few beds and cases per hospital even though Switzerland has one of the highest population densities in the world. This circumstance can most likely be explained by the federalist structure with (hidden) subsidization and a high interconnectedness to local politics (Felder, 2016).

Politically, two major actions have been undertaken by the Swiss government within the last years:

- the partial revision of the health insurance law (KVG) for hospital funding of 1.1.2009 and
- the new hospital funding regime as of 1.1.2012

The partial revision of the health insurance law (KVG) for hospital funding of 1.1.2009 has equated public and private hospitals in terms of compensation of services as of 1.1.2012 with the goal to increase competition leading to the fact that there can be public and private hospitals on the official hospital list (Berger, et al., 2015). The introduction of the new hospital funding regime as of 1.1.2012 was, according to Cosandey (2018), one of the biggest reforms within Swiss healthcare. The main points of the hospital funding regime are:

- the introduction of a list of hospitals officially accepted and paid via the cantons
- the Swiss-wide free choice of hospitals for patients
- the dual-fix financing of inpatient hospital costs (55 % of the cost covered by the cantons, 45 % by the health insurers)
- the obligation of more transparency about cost and quality of medical performance and
- Diagnosis Related Groups (Swiss DRG) case based rates

(Cosandey, et al., 2018). Those measurements were – as in other countries before – introduced with the goal to reduce cost without lowering quality (Busato & von Below, 2010; Cosandey, et al., 2018; santésuisse, n.d.). However, outpatient services (treatment and discharge on the same day without using a hospital bed or care) are still regulated within a separate system (TARMED) and in addition, there are currently other tariff systems for further hospital services (Camenzind, 2016; Cosandey, et al., 2018; Berger, et al., 2015; Busato & von Below, 2010). As in most OECD countries (OECD, 2017), in the Swiss healthcare context, about a third (35 %) of the healthcare cost come from hospitals, amounting up to 27 billion Swiss Francs in 2015 (Cosandey, et al., 2018, pp. 9-12) being financed by the cantons, the social insurances, private insurances and patients themselves (Berger, et al., 2015, p. 408) (cf. subsection 2.1.1.2).

The major part of hospital costs – 63,6 % – is attributed to wages (pwc, 2016, p. 10). In 2015, in Swiss hospitals 42 % of the full-time equivalents were care staff, 15 % facility management staff, 14 % medical doctors, 14 % other medical staff, 14 % administration staff and 1 % social service staff (Berger, et al., 2015, p. 403). According to Berger et al. (2015) in Switzerland, the economic impact of hospitals as enterprises and employers is often underestimated. In 2012, Swiss hospitals employed 4 % of the Swiss workforce creating 14.9 billion Swiss Francs of direct added value, generating a demand for goods and services of 8.1 billion Swiss Francs causing an indirect added value of 5.5 billion Swiss Francs or 43,000 further work places via the suppliers (Berger, et al., 2015, p. 397). The management of Swiss public hospitals has traditionally been the “tripod” of medical, care and administrative direction or the combination of medical and administration directors; the CEO principle is only now becoming more applied within private and privatized hospitals (Berger, et al., 2015).

Since the introduction of the new hospital funding regime in 2012 as described above, the base rates have been debated and adjusted. The measures have so far led to a stabilisation of the increase in expenses while quality could potentially be raised slightly (Cosandey, et al., 2018). However, despite the introduction of the DRG systems, the intention to intensify competition in order to lower cost has only partially been realized (Cosandey, et al., 2018): According to Camenzind (2016) and Cosandey (2018) the reasons for that are most likely of a political nature. Unclear roles among the political instances lead to a hindrance of competition due to regional political actions. However, the restructuring of the Swiss healthcare financing and hospital service landscape is currently in full progress, mainly on a political level, but also in an economic and socio-cultural dimension (Cosandey, et al., 2018; pwc, 2016). Fuelling this development is the fact that in the 1970s, the hospital infrastructure was broadly renovated after the hospital sector had grown massively in the 19th and 20th century, and that this infrastructure is now reaching the end of its lifecycle, not only in its substance, but also in terms of modernization of many other areas such as digitalization (Kutter, 2016).

2.1.2.5.2 Swiss Hospitals in the Future

The following aspects are forecast to be influencing hospitals in Switzerland in the future:

- Due to the demographic change in Switzerland, the expected proportion of people older than 65 years in 2030 is 22.8 %, which will potentially lead to an increase of complex multi-morbidity treatments, forcing the finding of solutions of institution overarching treatment (pwc, 2016).
- According to Berger et al. (2015) and Felder (2016), in the very dynamic, complex and politically influenced context of Swiss healthcare, it is difficult to denominate what an optimal number of hospitals and what the optimal financing mode in Switzerland is. But most likely, the revision of the Health Insurance Act (KVG) with the introduction of the case based rates (DRG) and the free choice of hospital for treatment will intensify competition – nationally and internationally (Angerer, et al., 2017; Berger, et al., 2015; Cosandey, et al., 2018; Felder, 2016).
- More competition, together with the forecast that the rates per case might decrease and the access to investment funds will become more difficult will most likely lead to a structural rationalization (Angerer, et al., 2017; Cosandey, et al., 2018; Paeger, 2017) entailing the need
  - for measurements to increase attraction e. g. by enhancing quality of all services or by optimizing the infrastructure in every aspect
  - to reduce operational cost e. g. by optimizing processes in all areas, by applying ICT to handle complexity or by using synergies between all the different disciplines, in all the involved medical and non-medical areas.

Healthcare institutions will (have to) cooperate more with other healthcare institutions and/or with institutions from other area (e. g. hotels, retirement homes) (Angerer, et al., 2017; Fosco, 2017).

- Swiss patients are expected to increasingly ask for higher (infrastructural) comfort and increased service quality forcing hospitals to invest in infrastructure and staff and to change the processes towards a patient centred approach (Angerer, et al., 2017; Fosco, 2017; pwc, 2016) leading to
  - a need (or chance) to conduct process reengineering and optimization omitting unnecessary steps
  - to enable availability of digital data for the patient as well as all involved health professionals and institutions (e-health)
  - more sophisticated possibilities of treatment thanks to the access to more (relevant, evidence based) data and
  - to enhanced possibilities to monitor the healing process with the aid of technological devices and new medical treatment and care.
- The staff shortage will most likely aggravate leading to the need to adjust organisational structures and professional profiles (Angerer, et al., 2017; pwc, 2016).
- The digital transformation and the technological development will also touch Swiss hospitals (Angerer, et al., 2017; pwc, 2016).

In order to embrace and meet the challenges of these trends, Angerer (2017), Cosandey (2018) and pwc (2016) suggest

- encompassing change management actions and measures throughout the whole hospital organisation
- new integrated, agile and proactive healthcare models including different post-discharge treatment solutions
- new business models and adequate legal forms including more flexibility for public hospitals and institutions, implemented by accompanied programmes on the journey to reach legal independence
- outsourcing of unprofitable or underutilised services
- inclusion of medical-technical and information and communication technology solutions to support service provisioning, eliminating current interface difficulties, using big data and artificial intelligence and increased automatisation
- more transparency and national quality criteria for benchmarking
- new role models for medical and care professions, as well as for other professions in hospitals also due to digitalisation.

In this thesis, the research subjects are hospitals according to the Swiss Federal Office of Public Health (BAG Bundesamt für Gesundheit, 2018) in the German-speaking area of Switzerland:
General hospitals, Centrum care (Level 1, University Hospitals)
General hospitals, Centrum care (Level 2)
General hospitals, Primary care (Level 3)
General hospitals, Primary care (Level 4)
Small general hospitals, Primary care (Level 5)
Psychiatric clinics (Level 1)
Psychiatric clinics (Level 2)
Rehabilitation clinics
Special clinics (Surgery, Gynaecology/Neonatology, Paediatrics, Geriatrics, Diverse)

2.2 Service Differentiation in Business and Management Research and Hospital Management

In this section, the understanding of service differentiation in Business and Management Research and hospital management is outlined and definitions of non-medical support services are presented. In Figure 6 the topic is schematically illustrated in the context of the conceptual basis.

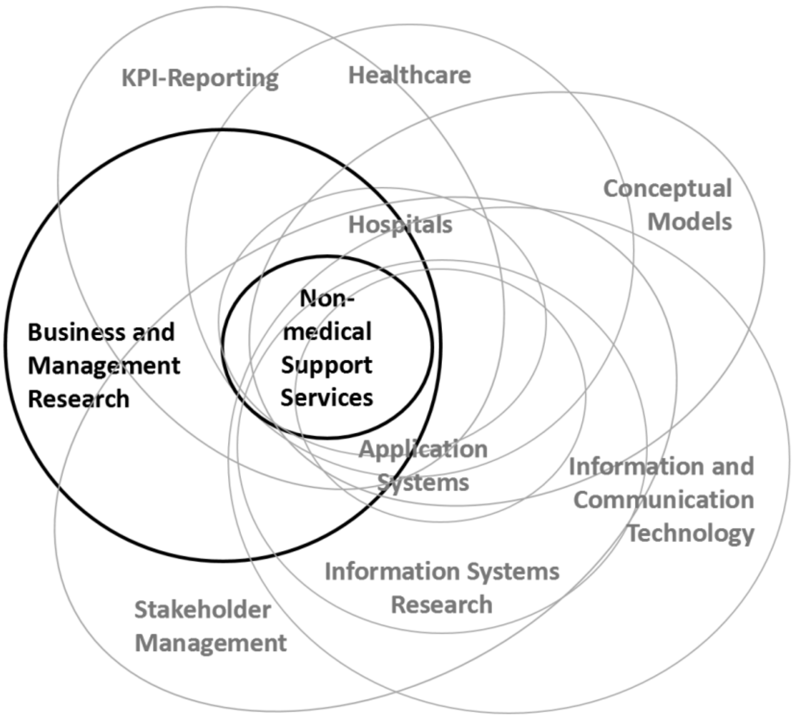

Figure 6: Business and Management Research and Non-medical Support Services as parts of the conceptual background chapter in this thesis based on Gerber (2018)

2.2.1 Business and Management Research

Business and Management Research started to emerge at the beginning of the 20th century and is thus still a relatively young discipline, dealing with scientific aspects of business administrational and management related topics like for example financing, human resources, marketing, logistics, production, research and development, market analysis, planning, cooperating, organisation and/or globalization (Eichhorn, 2008a; Pidd, 2009; Saunders, et al., 2016; Sreejesh, et al., 2014; Wilson, 2014). According to Wilson (2014, p. 3) Business Research is defined as “the systematic and objective process of collecting, recording, analysing and interpreting data for aid in solving managerial problems” or as “academic research on topics relating to questions relevant to business and management” by Bryman and Bell (2015, p. 5). The main goal of Business and Management Research is to provide adequate information about managerial problems like economic efficiency and opportunities and threats, both in general or in specific areas or industries, including findings of other disciplines like e. g. economics, social sciences or psychology anthropology in order to reduce uncertainty and to support systematic decision-making by executives (Bryman & Bell, 2015; Sreejesh, et al., 2014; Wilson, 2014; Zikmund, et al., 2013). According to Eichhorn (2008a), in the past, Business and Management Research had prevalently focused on privately owned production companies, while publicly-owned service companies have only recently been included as research objects, which particularly applies for research in hospital management which only started to be developed in the 1990s.

Like other disciplines, Business and Management Research can be conducted as basic/pure research or as applied research (Bryman & Bell, 2015; Easterby-Smith, et al., 2012; Mason, 2002; Sreejesh, et al., 2014; Zikmund, et al., 2013). Thommen (2004) divides the Business and Management Research discipline into

- functional aspects (core versus support processes)
- lifecycle aspects (foundation, operational and liquidation phase of a company)
- institutional aspects (specific needs and circumstances of industries)

- problem-oriented aspects (mergers & acquisitions, change and crisis management).

Sreejesh (2014, p. 3) points out that Business and Management Research can be done as

- market research ("aims at understanding and examining the marketplace in which the company operates")
- operations research ("involves use of mathematical, logical and analytical methods to find optimal solutions to business problems") or
- motivational research ("involves analysing the reasons and motives behind people's behaviour".

Zikmund (2013) distinguishes between

- Exploratory Business Research (high degree of uncertainty, unstructured research approach, answering a research question, applied in early stage of decision making)
- Descriptive Business Research (medium degree of uncertainty, structured research approach, answering a research question, applied in later stage of decision making)
- Causal Business Research (low degree of uncertainty, highly structured research approach, investigating a research hypothesis, applied in later stage of decision making).

Depending on the research question, van Aken (2004) differentiates between

- description-driven Business and Management Research (focus on the problem, explaining in hindsight, proof as justification applying explanatory sciences)
- prescription-driven Business and Management Research (focus on finding alternative solutions as intervention-outcomes, with saturated evidence as justification, applying design sciences)

Based on Gibbons et al. (2000), Burgoyne and Turnbull (2006), Pettigrew (2001) and van Aken (2004), knowledge production in Business and Management Research can be divided into

- Mode 1 and
- Mode 2 approaches.

Mode 1 represents the academic understanding of basic research with a rather homogenous, disciplinary, hierarchical understanding, while Mode 2 is defined as being "more socially accountable and reflexive. It includes a wider, more temporary and heterogeneous set of practitioners, collaborating on a problem defined in a specific and localised context." (Gibbons, et al., 2000, p. 3). Burgoyne and Turnbull (2006) see Design Science Research being a suitable and useful approach for Mode 2 researchers (cf. subsection 3.2.2.2).

Independently on the applied methods, Alvesson and Sandberg (2014), Birkinshaw et al. (2014), Hatchuel (2005) and Tsang (2017) emphasize that diversity and creativity in doing Business and Management Research is important "to make research more interesting and influential" (Alvesson & Sandberg, 2014, p. 38).

In this thesis, Business and Management Research is understood as applied prescription-driven research according to van Aken (2004) following the Mode 2 knowledge production characteristics according to Gibbons et al. (2000) and Burgoyne and Turnbull (2006) as being socially accountable, reflexive and involving the collaboration of heterogeneous sets for practitioners within a specific (problem) context.

The research conducted in this thesis has – according to Zikmund (2013) – an exploratory character in the "Theorising" phase and a descriptive character in the "Evaluating" phase (cf. subsection 3.2.2.2).

2.2.2 Hospital Management

Hospital management is, in addition to the general definition of management, characterized by its vast interdisciplinary nature including interrelations to "medicine, public health, epidemiology, national economy, demography, sociology, psychology, mathematics, information systems, philosophy (ethics), theology, geography, engineering and architecture" (Flessa, 2014, pp. 1-2 translated by the author) and particularly encompassing behaviour of patients and interactions between the medical and care staff and the patients (Eichhorn, 2008a). However, in the past, the discipline of hospital management has been seen rather as an inevitable evil, subsumed in the context of administration (Eichhorn, 2008a). During the development of the discipline within the last few years, hospital management has been more and more acknowledged as a very demanding task ensuring the operation of highly complex interlinked expectations, activities, disciplines and stakeholders; the discipline is however still in search for the adequate balance between the humanitarian tradition and the economical principles, striving to include the relevant topics in a holistic manner (Eichhorn, 2008a).

2.2.3 Service Differentiation

In this subsection, the service differentiation in general Business and Management Research and in hospital management in particular is presented.

2.2.3.1 Service Differentiation in Business and Management Research

In classical management theory (Porter, 1985; Rüegg-Stürm, 2003; Thommen, 2016), the services provided in enterprises are commonly divided into the following three levels:

- management processes
- core processes
- support processes.

Management processes typically encompass the normative, strategic and leadership activities; in the core or primary processes, the focus lies on the provision of services to the customer – the value chain – commonly including research and development, inbound logistics, operations, outbound logistics, marketing and sales services; in the support processes, the disciplines of human resource management, technology development, procurement, marketing and communication, administration, finance and controlling, legal services and facility or infrastructure management are allocated (Porter, 1985; Rüegg-Stürm, 2003; Thommen, 2016).

2.2.3.2 Service Differentiation in Hospitals

In hospitals, the differentiation of the various service levels turns out to be more difficult and there is no consistent definition. Some authors differentiate between the medical core and the non-medical non-core services – while being a very generic classification, it is not unanimously clarified if the medical support services belong to the core services or not (Abel, 2009; Engelke, 2008a; GEFMA 812, 2014-09; Renner, et al., 2001). Others differentiate in primary, secondary and tertiary services; the definition of what service provision belongs to which level however differs (Accenture & Private Universität für Gesundheitswissenschaften, Medizinische Informatik und Technik UMIT, 2004; Alfen, et al., 2005; Eichhorn, 2008b; Haubrock, 2018b; Lohfert, 2017). The same applies to the differentiation between medical services, care services and administrative services (Haubrock, 2009).

There are also different classifications of the non-medical support services: some sources refer to Facility Management (FM) standards, which themselves are defined with different views and without full congruency amongst each other (GEFMA 100-1, 2004-07; ISO 41011:2017 (E), 2017; SN EN 15221-4, 2011-12). Others name specific FM services, with or without separating them in categories like commercial, technical, infrastructural and other Facility Management areas (Goedereis, 2008; Lünendonk, 2015; Ruehle & Amelung, 2000). Engelke (2008b) makes a distinction between the administrative, technical, economic and supply area and management and field office. The most encompassing and holistic overview on services provided in hospitals is the "Service Allocation Model for Non-medical Support Services in Hospitals (LemoS)" by Gerber (2016). This model was developed based on the idea that in hospitals, there are different kinds of support services: management support services, medical support services and non-medical support services as illustrated in Figure 7.

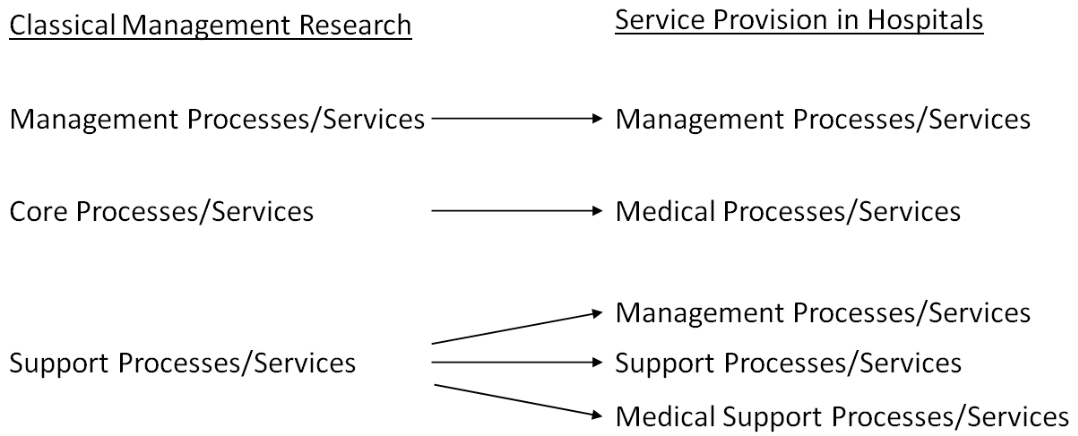

Figure 7: Support Services in Hospitals based on Gerber and Läuppi (2015, p. 5)

This led to the overall layout of service levels in hospitals illustrated in Figure 3.

2.2.4 Non-medical Support Services in Hospitals

The non-medical support services are further specified in the Service Allocation Model for Non-medical Support Services (LemoS) illustrated in Figure 8.

Figure 8: Service Allocation Model for Non-medical Support Services in Hospitals (LemoS) (Gerber, 2016, p. 6)

As shown in Figure 8, the non-medical support services according to Gerber (2016) are divided into the four areas Logistics, Infrastructure, Facility Services and Hotel Services with further service provisions leading to a total of 15 specific subject-areas:

Logistics

- Procurement (Tactical & Operational Procurement, Incoming Goods Control)
- Inventory Management
- Transport & Distribution (Internal / External Transportation of People & Goods, Mail / Courier Services, Relocation, Fleet Management, Disposal & Recycling)

Infrastructure

- Maintenance (Maintenance of Spaces, Parking Lot Maintenance, Building Maintenance & Technical Building Management, Operational Technology / Tenants, Specification / Medical Technology, Fittings & Furnishings Maintenance)
- Space Management (Internal Rental & Space Management, Property Administration)
- Energy

Facility Services

- Safety (Occupational Safety, Health Protection)
- Security (Personal Security, Fire Protection, Protection of Property, Technical Protection of Information, Environmental Protection)
- Cleaning (Cleaning of all Areas, Special Cleaning, Pest Control)
- Sterilisation

Hotel Services

- Catering (Patient / Resident / Staff & Guest Catering, Vending Services, External & Event Catering)
- Textiles (Patient Textiles and Workwear)
- Accommodation Administration & Operation of Properties (Staff & Guest Accommodations, Patient & Guest Hotel, On-Call Accommodation)

- Hotel Various (Owner-operated Kiosks & Shops, Event Management, Reception & Contact Center, Childcare, Media Library / Archive, Non-medical Patient Care)

The detailed service provisions within the mentioned subject-areas are all described in the "Service Catalogue for Non-medical Support Services in Hospitals (LekaS)" by Gerber and Läuppi (2015).

Due to the fact that the extent of non-medical support services is very broad, the circle of customers or beneficiaries is also very big, including at least all internal staff, but also patients, guests and other external parties (Abel, 2009; GEFMA 812, 2014-09). Nevertheless, in the past, with the main focus on medical service provision, support services and in particular the non-medical support services did not earn much attention or recognition (Bornewasser, 2013). Those services were often summarised under the term "administration" (Haubrock, 2009; Walther, 2005). Engelke (2008b) however indicates that factors like e. g. new systems for remuneration, labour market situation, legal and quality requirements, development of the market or new technological developments might influence the development of non-medical support services in hospitals. With the introduction of DRG systems, such a shift towards more focus on business management has been launched leading to a paradigm shift and thus a hierarchical change within hospitals (Bornewasser, 2013; Walther, 2005). This development is intensified by the fact that the services provided to patients are increasingly seen as all-embracing, including far more than medical treatment (Diez, 2009; Walther, 2005). At the same time, the technical, the infrastructural, and foremost the information systems and medical-technical development increase the importance of non-medical areas in hospitals or even lead to amalgamations of professions of formerly different professions (Beha, 2016; Diez, 2009; Lavy & Shohet, 2007; Lavy & Shohet, 2008).

However, in the quest to reduce cost, more than in other areas, the non-medical support areas have to implement cost-cutting measures and optimization initiatives (Bornewasser, 2013; Hizgilov & Redlein, 2011; Kriegel, 2012; Salfeld, et al., 2009). Korff (2012) and Salfeld et al. (2009) see big potential in making (non-medical) support services in hospitals more effective and more efficient e. g. by

- more automatisation
- applying more ICT tools in order to support and measure the business in an automated manner
- more outsourcing of unprofitable services and improved contracting management
- optimizing logistics (need-based procurement, reducing stock)
- more transparent internal service charges
- deliberate operational excellence thinking
- choice of best practice procedures
- organisational adaptations.

Whatever the measures are, Gerber (2016) points out the particular need for specific key performance indicators within the non-medical support services to facilitate controlling based on facts.

In this thesis, the research subjects are the non-medical support services in hospitals according to Gerber (2016) and Gerber and Läuppi (2015), illustrated in Figure 8.

2.3 Information and Communication Technology (ICT) and Information and Application Systems in General and in Hospitals

In this section, the context of Information and Communication Technology (ICT) and Information and Application Systems will be discussed, both in general as well as specifically in hospitals. In Figure 9, the topic is schematically illustrated in the context of the conceptual basis.

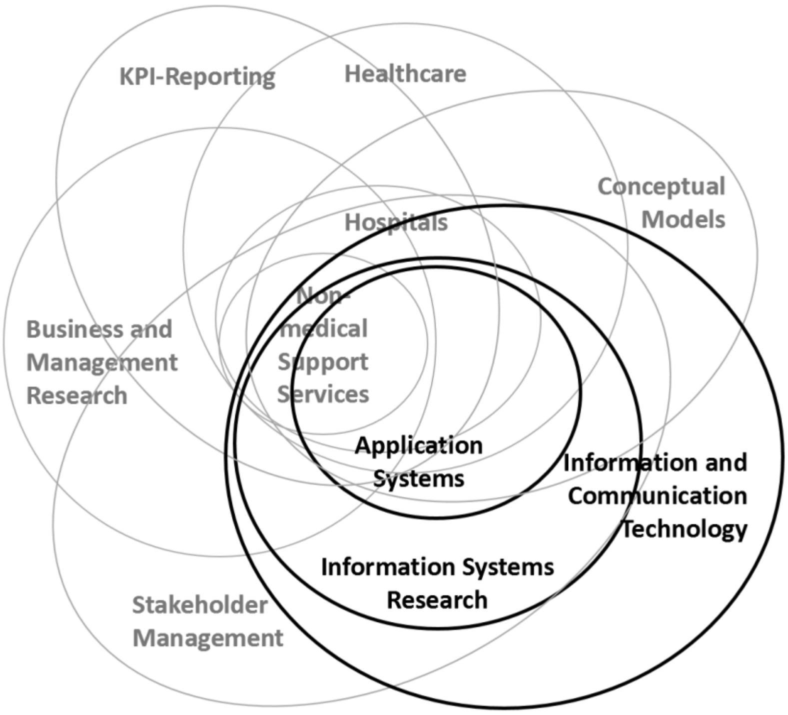

Figure 9: Information and Communication Technology, Information Systems Research and Application Systems as parts of the conceptual background chapter in this thesis based on Gerber (2018)

2.3.1 ICT Definition and Context

According to March and Smith (1995, p. 252)

> Information technology is technology used to acquire and process information in support of human purposes. It is typically instantiated as IT systems – complex organizations of hardware, software, procedures, data, and people, developed to address tasks faced by individuals and groups, typically within some organizational setting.

The goal of information and communication technology is to

- support people in information management and in decision making based on data and thus to
- increase efficiency and contribute to value enhancement of organisations
- accelerate data processing and distribution
- enable adaptation and developments
- minimize or prevent errors

(Bange, 2013; Ebel, 2015; Hassmann, 2018; March & Smith, 1995).

2.3.2 ICT in Hospitals

In this subsection, the specific context of ICT in hospitals is presented, taking a look at the past, present and future, the challenges and the suggested improvement steps.

2.3.2.1 ICT in Hospitals – Past, Present and Future

The historical development of ICT in hospitals is summarised based on Trill (2014):
Until the end of the 1980s, hospitals rarely possessed their own ICT-based data processing capacities – data was mainly processed mechanically in remote computer centres. Digitalization started with small applications e. g. in bookkeeping, executed by a few people at central terminals. Small applications were individually programmed. ICT departments did not yet exist. With the introduction of autonomous Hospital Information Systems (HIS) in the early 1990s, hospitals started to set up their own ICT departments and to process data in their own premises leading to more staff being involved in digital data processing. The focus was laid on administrative and/or technical aspects, medical staff potentially refused to accept ICT specialists as equal business partners supporting the core business.

Meanwhile, several developments influencing the service provision and also the perception of hospital ICT have been observed:

- merging of ICT and the medical engineering discipline (Beha, 2016; Janssen & Meissen, 2013; Lorenz, 2015), leading to staffing of ICT departments not only with technicians but with people from different disciplines, including the medical core areas (Trill, 2014)
- integration of standardised clinical pathways with real-time accessible patient data / E-Health (Fischlein & Pfänder, 2008; Hipp, 2016; Kleemann, 2010; Thun, 2009b; Trill, 2014)
- increased need for interlinking of data, applications, systems and stakeholders in new organisational forms and co-operations (Fischlein & Pfänder, 2008; Heckmann, 2017; Johner, 2016; Klemm, 2018; Oetiker, et al., 2014; Rockstroh, 2016; Schulze, 2018; Trill, 2014; Wurth, 2018)
- trend for process automatisation (Fischlein & Pfänder, 2008; Hipp, 2016; Kainsner, 2017)
- introduction and expansion of decision support information systems and performance management tools as a basis for future decisions and benchmarking (Fischlein & Pfänder, 2008; Gadatsch, 2013; Klemm, 2018; Walser, et al., 2013; Walther & Becker, 2009)
- rapid developments in the ICT discipline overall (hardware, software, data transfer and data storage) (Trill, 2014)
- prevalence of ICT and internet use for everybody enabling patients to individually retrieve information from the net community as well as to receive information about the hospitals online (Trill, 2014)

In literature, the relevance and new understanding of ICT as a game changer and/or process enabler of the future is undisputed in terms of

- handling complexity and interconnectedness
- enabling and ensuring transparency
- satisfying patients' requirements for digital information and services as well as patient involvement
- introducing individualized patient services both medical and non-medical
- developing new different health supply models
- relieving medical and care staff
- increasing patient safety and quality of treatment

- enabling information based management and controlling (e. g. Big Data, Business Intelligence) and thus
- enhancing effectiveness and efficiency e. g. by standardisation and automatisation and thus
- reducing risk and cost in both medical and non-medical processes
- aligning services in both medical and non-medical areas
- enabling innovation of any kind
- interoperability

(Behrendt, 2009; Dannemaier, et al., 2009; Fichman, et al., 2011; Fischlein & Pfänder, 2008; Gadatsch, 2013; Günther & Hartmann, 2007; Hassmann, 2018; Hoerbst, et al., 2011; Janssen & Meissen, 2013; Kainsner, 2017; Klein, 2014; Klemm, 2018; Köbler, et al., 2010; Kriegel, 2012; Niederhäuser, 2016; Oetiker, et al., 2014; Snedaker, 2017; Thiex-Kreye, 2009; Trill, 2017; VUD Verband der Universitätsklinika Deutschlands, 2014; Walser, 2012; Wurth, 2018).

At the same time, pressure on ICT in hospitals has also increased tremendously, especially by increased requirements in

- meeting regulations and financial objectives
- adequate service provision in all areas
- (cyber)security and governance aspects
- increasing quality of treatment and care
- a range of functions and higher usability of software applications
- providing new health services tools
- increased needs for interconnectedness between technology and institutions
- adaptability amongst existing and also towards new ICT aspects
- data processing capacities
- rapid development in (healthcare) information and communication technology
- increased mobility of hard- and software
- enabling economical objectives ensuring competitiveness
- responding to internet-focused patients

(Dannemaier, et al., 2009; Drauschke & Rottleb, 2018; Gocke & Schneider, 2017; Hartmann & Günther, 2015; Kriegel, 2012; Snedaker, 2017; Timm & Fazlic, 2017; Trill, 2014; Walser, 2012).

2.3.2.2 ICT in Hospitals – Challenges

In addition to challenges arising in the course of the above-mentioned development within ICT in general, ICT in healthcare in particular and also in healthcare and hospitals (cf. subsection 2.1.1.1 and 2.1.2.3), additional challenges have to be dealt with when managing ICT in hospitals:

- Even though the necessity of a penetrating ICT application as a success factor for better patient-treatment and for more successful hospital management has come to the awareness of many healthcare professionals, ICT maturity and readiness for investments in ICT and digitalisation (hard-/software as well as Human Resources) are still behind other industries (Behrendt, 2009; Fähling, et al., 2009; Fischlein & Pfänder, 2008; Flemming, 2015; Gadatsch, 2013; Günther & Hartmann, 2007; Hartmann & Günther, 2015; Hipp, 2016; Hoerbst, et al., 2011; Kenneally, et al., 2012; König, 2015; Müller, 2017; Snedaker, 2017; VUD Verband der Universitätsklinika Deutschlands, 2014).
- This fact often causes dissatisfaction for the parties involved: ICT employees have reduced opportunities to perform their job, hospital employees are hampered by reduced usability of the

products used and providers supply products with a lack of user acceptance (Hartmann & Günther, 2015; Kenneally, et al., 2012; Timm & Fazlic, 2017).

- Staff in many hospitals are still focused on paper based data processing and have little digital savvy as ICT is still often seen rather as a necessary evil than as a means of empowerment and its specialists and teams rather as administrative bureaucracy than as crucial business partners holistically enabling the core business (Behrendt, 2009; Hartmann & Günther, 2015; Hipp, 2016; Müller & Johner, 2009; Rasche, et al., 2010).
- As described in subsection 2.1.2.2, in the past, the culture of hospitals was driven by actions of parallel and sometimes competing and/or conflicting disciplines leading also to the development of isolated and independent software applications, lacking a common goal and missing interoperability and interconnectivity (Fischlein & Pfänder, 2008; Flemming, 2015; Gocke & Schneider, 2017; Günther & Hartmann, 2007; Kreglinger & Günther, 2016; Mauro, 2012; Tucker, et al., 2013; Waring & Wainwright, 2002).
- The missing focus on the patient process and the thus non-interdisciplinary approach (cf. subsection 2.1.2) led to decentralized ICT organisations with heterogeneous ICT landscapes and predominantly technically driven solutions leading to a very complex architecture with many standalone solutions, data redundancies, media disruptions and missing interoperability (Flemming, 2015; Gerber & Perschel, 2016; Günther & Hartmann, 2007; Hartmann & Günther, 2015; Hassmann, 2018; Hoerbst, et al., 2011; Mauro, 2012; Rübel, 2017; Thun, 2009b; Tucker, et al., 2013; VUD Verband der Universitätsklinika Deutschlands, 2014; Walther & Becker, 2009).
- The heterogeneous ICT development also led to the fact that very often there are no standardized ICT services or service level agreements causing not only financial intransparency but also unclear maintenance and updating cycles and thus higher risk and therefore higher cost (Behrendt, 2009; Flemming, 2015; Hartmann & Günther, 2015; Hoerbst, et al., 2011; Mauro, 2012).
- Software providers in the healthcare sector and particularly HIS providers have in the past built monolithic stand-alone solutions, not being very proactive in innovating and enhancing interoperability, now, with the new requirements and pressures leading to dissatisfaction in hospitals (Behrendt, 2009; Fischlein & Pfänder, 2008; Kenneally, et al., 2012; Timm & Fazlic, 2017).
- Missing overall strategies lead to short sighted individual decisions, potentially aggravating the situation (Günther & Kunhardt, 2007).
- Changing organisations lead to new, sometimes unclear or exaggerated ICT requirements (Drauschke & Rottleb, 2018; Janssen & Meissen, 2013; Trill, 2014).

2.3.2.3 ICT in Hospitals – Suggested Steps Towards Improvement

In order to cope with the mentioned challenges and to fulfil the current and future needs of ICT in hospitals, the following steps seem to be essential:

- clarification and understanding of the value, impact and possibilities of ICT on a medical and non-medical strategic / top management level as a basis for holistic strategic ICT decisions accompanied with the corresponding necessary funding and positioning of the discipline on a high strategic level within the organisation (Büchi & Rassadi, 2011; Fischlein & Pfänder, 2008; Günther & Kunhardt, 2007; Hartmann & Günther, 2015; Devearaj & Kohli, 2000; Janssen & Meissen, 2013; Johner, 2009; Kenneally, et al., 2012; Löbus & Meier, 2013; Schulze, 2018; Snedaker, 2017; Trill, 2014; Trill, 2017; Walser, et al., 2013; Walther & Becker, 2009; Wurth, 2018)

- training of all staff in the ICT context in order to foster the understanding and use of ICT in specific areas as well as to increase the awareness of the importance of ICT and the acceptance of the ICT staff so that ICT is understood as the core enabler and cooperation partner of all medical and non-medical processes, interconnecting the different disciplines, technologies and processes on all hierarchies (Flemming, 2015; Gadatsch, 2013; Gocke & Schneider, 2017; Hartmann & Günther, 2015; Johner, 2009; Kainsner, 2017; Kleemann, 2010; Kümmel, 2017; Löbus & Meier, 2013; Müller & Johner, 2009; Rasche, et al., 2010; Trill, 2017)
- reconsideration of all processes particularly in terms of patient centredness, best practice approaches and reduction of interfaces and the subsequent assessment of the ICT requirements of the optimized processes (Devearaj & Kohli, 2000; Fischlein & Pfänder, 2008; Flemming, 2015; Günther & Hartmann, 2007; Hartmann & Günther, 2015; Rasche, et al., 2010; Rübel, 2017; Santinelli, 2014; Snedaker, 2017; Thun, 2009b; Walther & Becker, 2009)
- optimization in a holistic, comprehensive manner, taking into account and connecting all involved disciplines and their stakeholders as well as technical and social aspects (Fischlein & Pfänder, 2008; Flemming, 2015; Kenneally, et al., 2012; Neri, 2013; Rasche, et al., 2010; Richter & Götz, 2013; Walser, et al., 2013; Walther & Becker, 2009)
- reaching comprehensiveness via interdisciplinary and cooperative procedures (internally as well as externally), preferably with the involvement of ICT in the role of a process and synergy enabler (Behrendt, 2009; Flemming, 2015; Hartmann & Günther, 2015; Johner, 2016; Kainsner, 2017; Kleemann, 2010; König, 2015; Kümmel, 2017; Löbus & Meier, 2013; Müller, 2017; Müller & Johner, 2009; Neri, 2013; Niederhäuser, 2016; Rasche, et al., 2010; Richter & Götz, 2013; Walser, 2012; Wurth, 2018)
- reducing complexity by integrating data, devices and software of all areas with the means of hospital engineering principles and by systematic orchestration and alignment of applications (Fischlein & Pfänder, 2008; Gadatsch, 2013; Gerber & Perschel, 2016; Heckmann, 2017; Kreglinger & Günther, 2016; Lavy & Shohet, 2007; Madritsch & May, 2009; Niederhäuser, 2016; Oetiker, et al., 2014; Rockstroh, 2016; Walther & Becker, 2009; Wurth, 2018)
- striving for standardisation, open application programming interfaces (APIs) and connectivity (Fischlein & Pfänder, 2008; Flemming, 2015; Hartmann & Günther, 2015; Heckmann, 2017; Klemm, 2018; Mauro, 2012; Rockstroh, 2016)
- enhancing the user experience and usability of applications and devices and enabling user-friendly but secure access (Wi-Fi / internet / TV / radio access) to information – for both staff and patients (Fischlein & Pfänder, 2008; Günther & Hartmann, 2007; Kleemann, 2010; Klemm, 2018; Niederhäuser, 2016; Oetiker, et al., 2014; Simon, 2018; Snedaker, 2017)
- support of all necessary aspects for safety and quality assurance (Günther & Kunhardt, 2007; Niederhäuser, 2016; Walther & Becker, 2009)
- centralization and standardization of ICT services and ICT processes as well as increased transparency (Gerber & Perschel, 2016; Hartmann & Günther, 2015; Walther & Becker, 2009)

2.3.3 Information Systems

In this subsection, the context of information systems is outlined in general as well as in the specific hospital context.

2.3.3.1 Information Systems in General

Information systems are a very important part of businesses and organisations in their endeavour to proceed (capturing, collecting, storing, maintaining, distributing) external and internal business relevant data and information at the right time and place in the appropriate quality while constantly adapting to changing requirements while respecting legal and prevalent requirements (Antonova, 2010; De Pablos Heredero & De Pablos Heredero, 2010; Delfmann, 2006; Haux, et al., 1998; Krcmar, 2015; Scheer, 2002; Teubner, 1990; vom Brocke, 2003; Wand, et al., 1995; Winter, 2013). However, there is no consistent definition of the term “information systems” in Information Systems Research literature.

In this thesis, the definition of information systems is used synonymously with business information systems and information and communication systems, covering a broader information systems understanding based on Winter and Aier (n.d.) including

- being task-related, dynamic, open socio-technical systems in organisations
- taking a mediating role between business applications and information and communication technology
- comprising technology (hard- and software), tasks and procedures, data, information and people
- enabling information processing activities and communication by interlinking different sub-systems
- consisting of information system components like sub-information systems, subsystems or information systems components

according to Antonova (2010), Delfmann (2006), Haux et al. (1998), Laux (2009), Riege et al. (2009), Scheer (2002), Seibt (2001)Speck (2001), Teubner (1990), Thomas (2006b), van Aken (2012) and Winter et al. (2005).

2.3.3.2 Information Systems in Hospitals

According to Ammenwerth (n.d.), Borzekowski (2002) and Heathfield et al. (1999), information systems have been applied in hospitals since the 1960s, starting to get more attention in the 1970s. The specific purpose of information systems in hospitals is to enable the

- identification
- collection
- management
- documentation and
- further processing

of data and information about

- health
- medicine
- care and
- administration

in order to support

- patient care
- business development
- education
- research and
- expansion of knowledge by interlinking the different involved disciplines and professional groups

(Borzekowski, 2002; Gocke & Schneider, 2017; Gräber, et al., n.d.; Laux, 2009; Hassmann, 2018; Haux, et al., 1998; Simoneit, 1998; Walser, et al., 2013).

There are various definitions of the term “Hospital Information System (HIS)” in literature, differing particularly in the scope of the included areas. A broader defined HIS includes all sub-information systems of all areas, facilities and disciplines in a hospital (Czap, n.d.; Gräber, et al., n.d.; Haas & Röhrig, 2009; Haux, 1995; Haux, et al., 2010; Kleemann, 2010; von Trotha, 1995; Walser, et al., 2013; Winter, et al., 2006). In a narrower sense, HIS is defined as comprising only the medical patient-centred data management (Czap, n.d.; Haux, 1995; Kleemann, 2010; Walser, et al., 2013; Winter, et al., 2005).

In this thesis, the broader definition of HIS including all sub-information systems of all areas, facilities and disciplines in a hospital according to Czap (n.d.), Gräber et al. (n.d.), Haas and Röhrig (2009), Haux (1995), Haux et al. (2010) Kleemann (2010), von Trotha (1995), Walser et al. (2013) and Winter et al. (2006) is used.

Based on Haux et al. (2010, p. 165), the following contributions should be made by an HIS

- “quality improvement,
- patient satisfaction, and
- cost reduction

[…]

- fulfilment of legal requirements,
- support of clinical research, and
- being a specialized medical competence centre.

[…]

- Efficient communication with other health providers (e. g., quick communication of discharge reports to the next health provider).
- All patient-related information is available during patient's stay.
- A comprehensive electronic patient record should be established.
- The use of personal mobile information processing tools should be extended.
- User interface design should be optimized to reduce the necessary teaching time.
- Patients should be able to access the content of “their” electronic patient record.
- Medical research should be able to exploit the data stored in the electronic patient record.”

Haux et al. (2010, p. 159) also provide specific examples for certain necessities of information quality aspects in hospitals:

- “The right information: Is the information correct, reliable, and valid? […]
- At the right time: Is the information available when the healthcare professional needs it *(just in time)*? […]
- At the right place: Is the information available wherever the healthcare professional needs it? […]
- To the right people: Is the information available only to the healthcare professional needing it? […]
- In the right form: Is the information available in a usable format for the healthcare professional?”

It becomes clear that the above described general information systems management indications also apply to hospitals. However, there turn out to be various peculiarities compared to other industries:

- Because of the historical development, HIS are often made out of many different subsystems or individual software applications from different software providers, being interlinked by individual interfaces or not at all; a well integrated, interdisciplinary information system in a hospital is rare; often, data is still stored in a non-digital manner (Behrendt, 2009; Furter, 2016; Gocke, 2006; Jobst & Pelikan, 1995; Niemann, et al., 2002; Raphael, 2013; Schweiger, 2007; Thun, 2009a).
- There is a high complexity in terms of aligning particular clinical workplace systems including medical applications, systems for clinical support, storage and archiving, patient terminals, specific emergency concepts and health research – all having to respect particular data protection, legal requirements and stakeholder needs (Gocke & Schneider, 2017; Hassmann, 2018; Haux, et al., 2010; Ingenerf & Stausberg, 2005).
- Different areas and institutions in hospitals have different maturities and penetration rates in the information systems context (Gocke & Schneider, 2017; Trill, 2017; Walther & Becker, 2009).
- A great number of legal aspects have to be respected, as healthcare is regulated in a national context, including local/national health regulations and organisations, data protection laws, political and financial procedures as well as medical-technical norms (Haux, et al., 2010).
- In the past, software providers for hospitals were not particularly interested in standardized, open systems and developed their systems individually and with limited interfaces (cf. subsection 2.3.2.2) leading to the fact that there are still no common standards at all in some contexts (Niemann, et al., 2002; Schweiger, 2007; Thun, 2009a; Welle, 2015).
- Despite the complexity and challenges to be handled, the ICT departments in hospitals still don't have the full management attention and less budget available than other industries (cf. subsection 2.3.2.2).

Behrendt (2009), Laux (2009) and Raphael (2013) point out that the above described need for the right information at the right time at the right place to the right people in the right form will increase immensely in the future. Therefore, a rise in numbers and an intensification of HIS projects can be expected, triggering the following steps and actions:

- The initiation of a shift from traditional monolithic HIS's towards heterogeneous, more and more integrated overall process-driven systems including interdisciplinary company-wide medical and non-medical data with the goal to have holistically integrated HIS's as a basis for good hospital management (Gocke, 2006; Hassmann, 2018; Jobst & Pelikan, 1995; Kipperhardt, et al., 2006).
- The aggregation and processing of data in order to receive decision-relevant information for the different stakeholder groups (Kipperhardt, et al., 2006; Haux, et al., 2010).
- For HIS projects: Focusing more on user benefits, ensuring adequate project (time) planning and project marketing as well as extensive communication, and implementing acceptance and training measures keeping in mind the need of expert organisations (Behrendt, 2009; Hassmann, 2018; Simoneit, 1998; Trill, 2017).
- The need to reduce complexity by using modelling techniques when trying to create a basis for a common understanding and the recognition of the importance of information systems management and engineering amongst the stakeholders (Frank, n.d.b; Niemann, et al., 2002).

2.3.4 Software Applications, Application Systems, Analytic Information Systems and Application Integration

In this subsection, the context of software applications and application systems, analytic information systems and application integration will be outlined.

2.3.4.1 Software Applications and Application Systems

This subsection summarises the context of software applications and application systems in general and in hospitals.

2.3.4.1.1 Software Applications and Application Systems in General

According to Encyclopaedia Britannica (n.d.) and Kurbel (2014), software is the immaterial part of a computer system, hence programmes executed on computers. Delfmann (2006) differentiates between Core Software and Application Software as illustrated in Figure 10.

As the goal of this thesis is to contribute to the development of non-medical support applications in hospitals dealing with key performance indicators (cf. section 1.3), the focus is on application software according to Delfmann (2006, p. 37), being a product either purchased or developed in-house as a standard, customized or individual program or package, installable on a computer system, offering functions and data for a specific task performed by a user in his/her business processes (Hanhart, 2008; Haux, et al., 1998; Scheer, 2002; Stahlknecht, 2001; Thomas, 2006a).

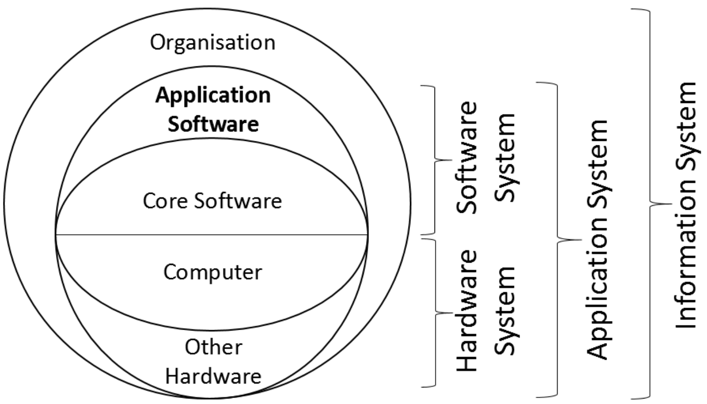

Figure 10: Differentiation between information, application, hardware and software system adapted from Delfmann (2006, p. 37), translated by the author

The quality of a software can be defined by asking the following questions:

- “Functionality: Are the required functions available in the software?
- Reliability: How reliable is the software?
- Usability: Is the software easy to use?
- Efficiency: How efficient is the software?
- Maintainability: How easy is it to modify the software?
- Portability: How easy is it to transfer the software to another environment?”

(Haux, et al., 2010, pp. 153-154).

Application systems

- are computer systems which process data and information
- can be individually customized for single users or standardized for many users
- have the goal to link the technical side of the system with the needs of human users, providing functions
- include hardware and software systems
- can have very complex structures made out of modules, data, components, standard software, industry software and in-house developments

(Delfmann, 2006; Haux, et al., 1998; Scheruhn, 1997; Teubner, 1990; Thomas, 2006a; Winter, 2006). The differentiation between information systems and application systems is illustrated in Figure 10.

2.3.4.1.2 Software Applications and Application Systems in Hospitals

The definition of application systems also applies for application systems in hospitals. What is specific about the hospital context is the fact, that many totally different software applications are needed to provide the hospital services. Currently, the following main areas of software applications can be distinguished in hospitals:

- software for the medical core processes (HIS software in the narrow sense, cf. subsection 2.3.3.2)
- strategic management and business administration software / Enterprise Resource Planning (ERP)
- Computer Aided Facility Management software (CAFM)
- special individual software of specific areas (medical or non-medical) / single software solutions

(Gadatsch, 2013; Gerber, et al., 2016).

Software for the medical core processes (HIS software in the narrow sense, cf. subsection 2.3.3.2) includes all aspects of medical data documentation of patients from admission, anamnesis, diagnosis, treatment planning, medical and care treatments, discharge, invoicing, transfer to other healthcare institutions, archiving etc. typically representing the above discussed HIS software in a narrower sense (imbi, 2001; Winter, et al., 2006).

Strategic management and business administration software comprises all aspects of running, controlling and monitoring the hospital as a business, managing all the necessary resources like staff, time, rooms, material, medication, devices, finances etc., typically called Enterprise Resource Planning (ERP) software (De Pablos Heredero & De Pablos Heredero, 2010; imbi, 2001; Gronau, 2014; Winter, et al., 2006).

CAFM software deals with the specific infrastructural needs of facilities e. g. space management, locking systems, maintenance management, safety and security management (GEFMA 400, 2013-03; May, 2013; Shohet, et al., 2004).

Special individual software of specific areas (medical or non-medical), also called single software solutions are any software specifically programmed or purchased for a particular person or department, not being included in any of the above-mentioned areas, e. g. Research & Development applications (imbi, 2001; Gerber, et al., 2016).

2.3.4.2 Analytic Information Systems / Business Intelligence (BI)

This subsection presents the context of analytical information systems and Business Intelligence (BI) both in general and in the context of hospitals.

2.3.4.2.1 Analytic Information Systems / Business Intelligence in General

Since the 1970s, Business Intelligence (BI) or analytic information system tools have been applied for the collection, processing and distribution of data for planning, controlling and monitoring the large amount of collected and generated data within application systems (Bange, 2013; Chamoni & Gluchowski, 2013; De Pablos Heredero & De Pablos Heredero, 2010; Winter, 2013).

According to Raphael (2013), different degrees of BI definitions are used:

- A narrow understanding of BI: This includes Online Analytical Processing (OLAP) – a software technology using multidimensional conceptual perspectives (OLAP cubes) for supporting managers by providing information (Gluchowski, et al., 2008; Krcmar, 2015; Laudon, et al., 2016) – and Management Support Systems (MSS) – individually configured, scalable and adaptable software systems supporting managers in their task of decision making including Executive Support Systems, Management Information Systems (MIS), Decision Support Systems (DSS) and Executive Information Systems (EIS) (Gluchowski, et al., 2008; Laudon, et al., 2016; Raphael, 2013).
- An analytically oriented understanding of BI, which adds other analytical tools to the narrow understanding: Data Mining – having the goal to maintain a logical, central and consistent data pool with the objective to do complex and undirected analysis of data in order to find patterns by the means of statistical procedures, machine learning and artificial intelligence, supporting planning, forecasting, diagnosing and interpretation (Bange, 2013; Gluchowski, et al., 2008; Krcmar, 2015; Laudon, et al., 2016) – or processing key performance indicators (discussed in detail in section 2.4).
- A broad understanding of BI, yet adding the context of Data Warehousing whose goal it is to run thematically oriented, integrated, time-bound, long-term collections of decision-relevant data as a basis for further analysis (Bange, 2013; Gluchowski, et al., 2008; Krcmar, 2015; Laudon, et al., 2016).

2.3.4.2.2 Analytic Information Systems / Business Intelligence in Hospitals

As already discussed, nowadays, the amount of collected and stored data is immense and the need for data analysis and data interpretation is constantly increasing, leading to the conclusion that the aspect of Business intelligence (BI) presented above also – and particularly – applies to hospitals, even though this aspect doesn't seem to have been in the main focus of hospital managers in the past (Kipperhardt, et al., 2006; Raphael, 2013; Ratia, et al., n.d.).

2.3.4.3 Application Alignment and Integration

This subsection presents aspects of application alignment and integration in general as well as in hospitals in particular.

2.3.4.3.1 Application Alignment and Integration in General

Throughout the historical development of application architectures (monolithic applications until the 1980s, implementation of standard software like SAP R/3 until the end of the 1990s), redundancies and non-integrated application architectures have been built, including dozens if not hundreds of heterogenous (legacy) applications and sub-systems in companies and institutions, particularly within medium and large enterprises (EABPM, 2014; Hafner, et al., n.d.; Khoumbati & Themistocleous, 2007; Klesse, et al., 2005; Linthicum, 2000; Schwinn, 2005). This leads to a tremendous amount of time and money needed for the maintenance and securing of interfaces between the applications and sub-systems (Haux, et al., 1998; Khoumbati & Themistocleous, 2007; Schwinn, 2005). It is thus a logical continuation of the historical development that it becomes increasingly important to

- assess and document the current application systems
- understand the big picture of software architecture
- detect and reduce redundancies
- prioritize and choose applications based on systematic criteria
- integrate software applications and
- implement common architectures

in order to

- reduce time and cost necessary to handle the complexity
- enhance flexibility
- improve response times
- and very importantly to reduce security risks

(De Pablos Heredero & De Pablos Heredero, 2010; Haux, et al., 1998; Linthicum, 2000; Mantzana & Themistocleous, 2004; Schwinn, 2005; Siegenthaler & Schwinn, 2006; Themistocleous & Irani, 2003; Winter, 2006).

The goal of this thesis is to develop a reference model providing the necessary information about a standardized procedure and its significant aspects for aligning non-medical-support service applications in hospitals so that relevant key performance indicators for a systematic controlling and optimization can be generated and configured (cf. section 1.3). Thus the focus lies on the aspect of alignment and integration of applications.

To integrate applications, different technical aspects have been applied and developed, e. g. looking at integration technologies (message oriented technologies, database oriented middleware, object oriented technologies, transaction based technologies, interface oriented technologies), architectures (service oriented architectures, Enterprise Application Integration) or methods/components (integration engines / brokers, web services) (EABPM, 2014; Haux, et al., 2010; ITWissen.info, n.d.a; ITWissen.info, n.d.b; ITWissen.info, n.d.c; ITWissen.info, n.d.d; ITWissen.info, n.d.e; Kalyani, 2012; Khoumbati, et al., 2005; Khoumbati & Themistocleous, 2007; Linthicum, 2000; Losavio, et al., 2005; Moturi, et al., 2013; Niemann, et al., 2002; Ruh, et al., 2001; Schweiger, 2007; Schwinn, 2005; Siegenthaler & Schwinn, 2006; Themistocleous & Irani, 2002; Themistocleous & Irani, 2006; van den Bosch, 2010; Wei, 2015; Winter, 2006). However, the need has become apparent for additional aspects like

- more alignment of processes between business and ICT as far as possible
- pursuing the development of an overall, gradual, step-by-step integration strategy
- including decisions like integrating horizontally (along the value chain) or vertically (via the dispositive administrative or logistic applications)

- what the integration scope and depth should be
- deciding if an integration should happen intra-organisationally, inter-organisationally or in a hybrid manner
- on which level the integration should be conducted (presentation level, data level, object level, functional level)
- controlling redundancy (definition of master data source)

(EABPM, 2014; Frank, 2014; Gronau, 2014; Klesse, et al., 2005; Ruh, et al., 2001; Schwinn, 2005; Siegenthaler & Schwinn, 2006; Themistocleous & Irani, 2002; Winter, 2006). In order to overcome these aspects, many challenges and barriers in integrating applications have to be mentioned:

- heterogeneous, incompatible, unstructured information system models and products
- great complexity in different contexts
- fixed structures
- different maturities of integration technologies
- balancing homogeneity versus heterogeneity and functional leanness versus functional redundancy
- financial implications
- organisational culture not embracing integration
- shared data with differing use and priorities
- unclear communication amongst stakeholders
- shortage of skilled staff or technical and contextual expertise

(Haux, et al., 1998; Johannesson, 2001; Mocker, 2009; Schwinn, 2005; Themistocleous & Irani, 2002).

2.3.4.3.2 Application Alignment and Integration in Hospitals

The aspects of application alignment and integration concern hospitals as much as other industries, if not even more due to their historical organisational and software application development (cf. previous subsections) (Haux, et al., 2010; Jobst, 2010; Khoumbati, et al., 2005; Khoumbati & Themistocleous, 2006; Mantzana & Themistocleous, 2006; Snedaker, 2017). As special motivators for alignment and integration of applications in hospitals, Khoumbati et al. (2005) have determined

- technical reasons
- reducing medical errors
- having clinical decision support
- ensuring security and confidentiality of patients' data

Enterprise Application Integration (EAI) projects in hospitals conducted by Khoumbati and Themistocleous (2006), Khoumbati and Themistocleous (2008), Mantzana and Themistocleous (2004), Mantzana and Themistocleous (2005), Mantzana and Themistocleous (2006) and Mantzana et al. (2008) have revealed the following important aspects influencing application integration adoption:

- Benefits
- Barriers
- Costs
- Compatibility
- Internal pressures
- External pressures
- ICT infrastructure
- ICT support

- ICT sophistication
- Evaluation drameworks
- Telemedicine
- Organisational size
- Patient satisfaction
- Physicians’ and administrators’ relationship

As the research aim of this thesis is to develop a reference model providing the necessary information about a standardized procedure and its significant aspects for aligning non-medical support service applications in hospitals (cf. section 1.3), the findings about important aspects influencing integration adoption by Khoumbati and Themistocleous (2006), Khoumbati and Themistocleous (2008), Mantzana and Themistocleous (2004), Mantzana and Themistocleous (2005), Mantzana and Themistocleous (2006) and Mantzana et al. (2008) are taken as a conceptual basis.

2.3.5 Information Systems Research as a Discipline

“Information Systems” is not only the context as described in the previous subsections, but also a relatively young discipline. It started its development in the 1960s with the emergence of a niche due to the fact that not all aspects of technological developments, increasing application of ICT in data processing and Operations Research in practice was covered by the discipline of Informatics (Delfmann, 2006; Hess, 2010; Lange, 2006; Sinz, n.d.). In the discipline of Information Systems (IS), the information systems and communication systems are understood as ICT-based socio-technical systems, including interdependent human and machine components as means to provide information on one side and possibilities to communicate in order to support business and administration and its strive for reaching the business goals on the other side (Braun, et al., 2004; Burwitz, et al., 2013; Frank, 2007b; Frank, 2009; Hess, 2010; Hess, n.d.; Lehner, 2001; Sinz, n.d.).The IS discipline thus

- operates between tasks, technical components and people in business management and information and communication technology
- includes non-automated, partially automated or fully automated contexts
- deals with the analysis, concept, development, management, use and maintenance of (internal, inter-company, and inter-organisational) operational information and application systems of organisations
- includes business process tasks as well as management tasks
- deals with different kinds of integration questions (static, functional, dynamic)
- takes care of the development of procedures, methods and norms including technical and human aspects
- tries to reduce complexity in order to enable the successful handling of IS
- enables aspects of alignment and integration

(Aier & Winter, 2008; Braun, et al., 2004; Burwitz, et al., 2013; De Pablos Heredero & De Pablos Heredero, 2010; Delfmann, 2006; Frank, 1997; Frank, 2007b; Frank, et al., 2007; Frank, et al., 2014; Hess, 2010; Hess, n.d.; Lehner, 2001; Österle, et al., 2010; Österle & Otto, 2009; Scheer, 2002; Sinz, n.d.; Thomas, 2006b). Comparing the disciplines of IT and IS, IT has the technical focus of Informatics while IS has the more socio-technical focus including stakeholder management; contrasting Business Administration (BA) with IS, BA is focusing on the economic side of information, while IS deals more with the information processing of BA systems (Frank, 2000a; Frank, et al., 2014; Galliers, 1992; March & Smith, 1995; Österle, et al., 2010; Sinz, n.d.; Strecker & Fettke, 2014).

2.3.5.1 Information Systems Research (ISR)

The goal of ISR is to develop theories, methods, tools and inter-subjectively reviewable knowledge production to support the discipline of IS (Braun, et al., 2004; Frank, 1997; Frank, 2007b; Frank, 2009; Frank, n.d.c; Hess, 2010; Krcmar, 2015; Österle, et al., 2010). ISR is mainly seen as application-oriented (Braun, et al., 2004; Frank, 1997; Hess, n.d.; Schütte, 1998). ISR is coinciding and thus using methodologies and principles with organisational theory, engineering, business, management and computer science, labour economics, systems theory, cybernetics, psychology, cognitive science and sociology (Bichler, 2016; Frank, 2007b; Frank, 2009; Frank, et al., 2014; Galliers, 1992; Sinz, n.d.). Österle et al. (2010) see ISR as not being able to produce deterministic solutions due to its complex context. Implications of the discipline's closeness to practice are widely discussed. While Ostrowski (2012) and Rasche et al. (2010) point out the necessity of service-orientation and collaboration between researchers and practitioners and while Goeken (2003) presents arguments about the importance of scientific support of practical know-how, Frank (n.d.a) and Österle et al. (2010) emphasize the importance of fulfilling scientific criteria like originality, abstraction, justification, generalizability, relevance, utility and transparency / dissemination also within ISR. Alexander (1973) and Alexander et al. (1977) came up with the design (pattern) approach in the context of architecture and industrial design, inspiring Simon (1996) who published “The Sciences of the Artificial” triggering the idea of Design Science Research (DSR). The emergence of this paradigm caused intensive discourses and disputes between the different representatives of the discipline, and particularly between the English-speaking research community with a predominantly behaviouristic approach and the German-speaking (“Wirtschaftsinformatik”) research community with a more design- and construction-oriented approach on the possible and proper approaches to be applied in conducting and evaluating research in ISR (Baskerville, et al., 2011; Becker & Pfeiffer, 2006; Becker, et al., n.d.c; Frank, 2007a; Gubler, 2012; Österle, et al., 2011; Wilde & Hess, 2006; Wilde & Hess, 2007; Zelewski, 2009). In Table 1, the differences between the ideal-typical behavioural science/explanatory paradigm and the design-oriented/DSR paradigm are listed.

Table 1: Differences between the ideal-typical behaviouristic approach and the design-oriented approach based on Becker & Pfeiffer, 2006; Becker et al., n.d.c; Dresch et al., 2015a; Frank, n.d.a; Gubler, 2012; Hevner & March, 2003; Hevner et al., 2004; Hevner & Chatterjee, 2010; March & Smith, 1995; Niehaves, n.d.; Österle et al., 2010; Österle et al., 2011; van Aken, 2012; Wilde & Hess, 2006; Wilde & Hess, 2007; Winter, 2008

	Behaviouristic approach	**Design-oriented approach**
Goals	Description and explanation of the reality according to theories / world that is **-> Quest for truth / knowledge as an end / representational**	Change and improvement of reality with artefacts / world that can be **-> Focus on effectiveness / knowledge as a means / pragmatic**
Composition of knowledge	Idea that socio-technical interrelations can be explained by empirical data **-> Reductionism**	Data are the basis for the artefact construction, conclusions on the general context cannot be derived **-> Emergence**
Relation problem - solution	Solution as a **-> Consequence of a well-structured problem / problem focused**	Problem and solution as **-> Co-evaluation / solution focused**
Development of knowledge creation	Survey, Analysis, Interpretation, Generalization **-> Sequence**	Problem analysis/observation and formulation, development and adaptation of concepts, ideating, evaluation and recalibration, synthesis **-> Iterations**
Interaction with the object of research	Avoiding actions that influence the object of research **-> Observation**	Active use of specific possibilities of field influence **-> Participation**
Justification	Rigour before relevance **-> Explanatory validity / statistical significance**	Relevance before rigour **-> Pragmatic validity / utility**
Driven by	Pure knowledge problems **-> Observer perspective**	Field problems **-> Actor perspective**
Typical research product	Hypotheses and empirically justified theories, reactive explanation of environment and predictions, theories **-> The causal model**	Innovations/artefacts, proactive development and evaluation of prototypes and artefacts **-> Generic solution and the design proposition**
Research paradigms	Theorising and justifying, finding truth **-> Basic research**	Building and evaluating artefacts, finding utility **-> Applied research**
Research question	**-> How and why?**	**-> How well / to what extent?**

In this thesis, the underlying understanding of the design-oriented approach of Information Systems Research as described in Table 1 is applied.

2.3.5.2 Design-oriented Information Systems Research / Design Science Research (DSR)

In literature, there is an inconsistent use of the term Design-oriented Information Systems Research and Design Science Research (Goldkuhl, 2012; Gericke & Winter, 2009).

In this thesis, the terms Design-oriented Information Systems Research and Design Science Research are used synonymously.

Even though there is no unanimous definition of DSR, the following principles can be derived from literature:

- DSR is interested in solving relevant real-world field problems and thus improving practical issues and/or predicting future events.
- DSR tries to understand the context as much as possible in order to develop and evaluate useful and innovative artefacts.
- DSR operates with iterative interactions between academia and practice, trying to bridge the gap between theory and practice.
- DSR combines multiple methods in a pragmatic manner throughout the whole research process while fulfilling the postulates for scientific research: originality, abstraction, justification, transparency, verifiability.
- DSR contributes to practical and scientific developments of knowledge.

(Anderson, et al., 2012; Becker & Pfeiffer, 2006; Borek, et al., 2012; Dresch, et al., 2015; Frank, 2007a; Frank, 1997; Greiffenberg, n.d.; Hevner, et al., 2004; Hevner & Chatterjee, 2010; Lange, 2006; March & Smith, 1995; March & Storey, 2008; Niehaves, n.d.; Ostrowski, 2012; Ostrowski, et al., 2012; Picot, 2010; Purao, 2002; Schütte, 1998; Simon, 1996; Strecker & Fettke, 2014; van Aken, 2004; van Aken, 2012; Wieringa, 2014)

In this thesis, Design Science Research is understood as operating in the socio-technical context including humans, organisations and technology, explicitly trying to involve the concerned stakeholders from the business in reality and specialists from different fields with the goal to gain knowledge about methods, techniques and information systems themselves as well as to deliver innovative methods, techniques and models in order to improve the realization, use and maintenance of information systems in organisations (Becker, et al., 2003; Frank, 1997; Frank, 2007b; Frank, 2009; Frank, n.d.a; Strecker & Fettke, 2014; Österle, et al., 2010; Sinz, n.d.; Wilde & Hess, 2006).

As discussed above, one of the main focusses of DSR is the creation of artefacts with utility and a certain novelty as outcome with the goal to overcome real-world problems (Anderson, et al., 2012; Dresch, et al., 2015; Goldkuhl, 2012; Hess, 2010; Hevner, et al., 2004; Hevner & Chatterjee, 2010; Ostrowski, et al., 2012; Purao, 2002). According to Gericke and Winter (2009), artefacts can be distinguished by

- their nature: typical DSR artefacts are
    - constructs
    - models
    - methods and
    - instantiations

(Dresch, et al., 2015; Hevner & March, 2003; Kenneally, et al., 2012; March & Smith, 1995; Winter, 2008; Vaishnavi & Kuechler, 2004).

Manifestations of those DSR artefacts can be

- (normative, practical) guidelines

- (conceptual) frameworks
- specifications of processes
- organisational structures
- norms
- patents
- glossaries
- open source code for software
- implementations
- prototypes

(Aier & Winter, 2008; Becker & Pfeiffer, 2006; Frank, 2007a; Hess, 2010; Österle, et al., 2010).
Whether theories and/or testable design product hypotheses are also DSR outputs has not yet been finally concluded within the DSR community (Dresch, et al., 2015; Hevner, et al., 2004; Purao, 2002; Riege, et al., 2009; Vaishnavi & Kuechler, 2004; Vaishnavi & Kuechler, 2008).

- the nature of dealing with the artefacts:
  - constructing them (constructing, evaluating or situationally adapting them) or
  - researching about them (research about the foundation of the construction or evaluation).

As the goal of this thesis is to develop a reference model as an artefact (cf. section 1.3), the focus lies on the model construction and evaluation as illustrated in Figure 11.

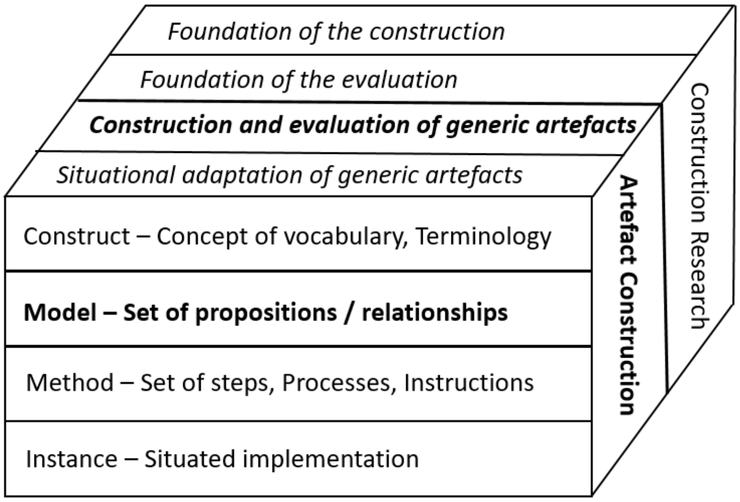

Figure 11: Definition of artefact type developed in this thesis based on Gericke and Winter 2009

Burgoyne and Turnbull (2006) see DSR as appropriate for Business and Management Research, particularly in the Mode 2 context (cf. 2.2.1) and Vaishnavi and Kuechler (2008) claim that DSR is a pragmatic discipline because of the emphasis on relevance, trying to deliver useful artefacts for the real world. However, in order to support business and its strive for reaching the business goals, DSR faces several challenges: It has to

- deal not only with the information and communication technology involved, but has to specifically understand the application context and the design of useful artefacts in order to reach the area specific and formal goals
- consider the suitable methods within the broad context
- provide particularly specific explications of the applied methodologies to justify their suitability
- choose the specific vocabulary and diction of different involved scientific disciplines and practices in order to bridge potential gaps

(Becker, et al., 2003; Frank, 1997; Frank, 2007a; Frank, et al., 2007; Hess, n.d.; Niehaves, n.d.; Österle & Otto, 2009; Österle, et al., 2010; Österle, et al., n.d.a; Pervan & Klass, 1992; Picot, 2010; Strecker & Fettke, 2014). According to Österle and Otto (2009), the degree of the ability to capture the business context largely influences the extent of the effectiveness of the DSR outcome.

2.3.5.3 Design Science Research (DSR) in Healthcare

Even though the Department of Health & Human Services (2017) mentions Design Research as a method to apply in the Health ICT context and examples of applied DSR principles like the project "Enhancing Benefits form Healthcare ICT Adoption Using Design Science Research" and the application of the DSR Guidelines by Hevner et al. (2004), Kenneally et al. (2012) and Health ICT (n.d.) exist, documentation on DSR in healthcare has been scarce. Hevner and Chatterjee (2010) explain this situation by the fact that Healthcare ICT systems involve many medical and non-medical stakeholders, some of which had not been willing to deal with the challenges posed in the past.

Based on the previously mentioned estimations that DSR principles are appropriate for research and development projects in Mode 2 approaches in Business and Management Research (cf. subsection 2.2.1), in design-oriented information systems research (cf. subsection 2.3.5.2) and the Hospital Information Systems context (2.3.5.3), for this thesis, DSR principles were chosen.

2.4 Key Performance Indicators (KPIs) and Reporting in General and in Hospitals

In this section, the context of KPIs and their reporting is discussed, both in general and in hospitals in particular. The context of the topic is illustrated schematically in Figure 12.

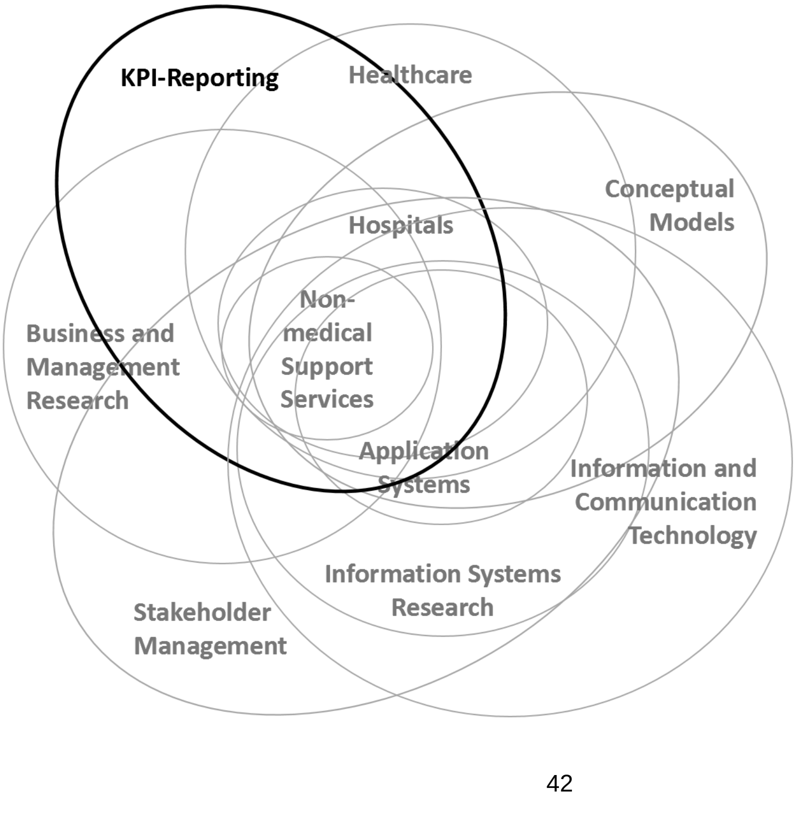

Figure 12: Key performance indicators and their reporting as parts of the conceptual background chapter in this thesis based on Gerber (2018)

2.4.1 Key Performance Indicators (KPIs) and Reporting in General

KPIs are values reporting organisationally critical/important measured quantities in a (highly) compacted manner (Botta, 1997; Gladen, 2014; Reichmann, et al., 2017; Parmenter, 2015; Preissler, 2008; Zapp, 2010). The goals to define, collect and analyse KPIs are to

- have a solid and objective basis for planning and assessment
- monitor and control important factors
- have forward indicators for detecting chances for success
- detect weak points
- make complex circumstances and interlinks transparent and comprehensible
- show the financial and/or economical development and/or situation of an organisation
- compare/benchmark
- set goals and/or standards
- build strategic success factors and/or reduce risks

(Botta, 1997; Capone, 2015; Gladen, 2014; Haubrock, 2018d; Hess, 2005; Johner, 2009; Preissler, 2008; Reichmann, et al., 2017; Staehle, 1969; VDI, 1999). The application of KPIs is thus particularly important for managers and internal and external decision makers (Gladen, 2014; Johner, 2009; Marr, 2012; Preissler, 2008; Staehle, 1969; Zapp, 2010).

KPIs can be categorized in different perspectives:

- static form: Absolute/cardinal numbers (individual figures, sums, differences, mean values) vs. relative figures/ratios (structuring figures, relation figures, index figures) (Botta, 1997; DIN, 1996; Gladen, 2014; Haubrock, 2018d; Preissler, 2008; Reichmann, et al., 2017; Staehle, 1969; Zapp, 2010)
- financial ratios: investment ratios, financing ratios, solvency ratios, return ratios vs. output-oriented ratios/productivity figures vs. quality ratios/indicators: structure quality, process quality, output quality (DIN, 1996; Moness, 2010; Reichmann, et al., 2017; Staehle, 1969; Zapp, 2010)
- value based figures: short-term figures vs. long-term figures (Zapp, 2010)
- approach to action: normative (including recommendations for actions) vs. descriptive (statements of facts) (DIN, 1996; Reichmann, et al., 2017)
- time reference of measures: past measures, current/real time measures, future measures (Haubrock, 2018d; Hess, 2005; Parmenter, 2015; Preissler, 2008)
- variance analysis: target actual difference vs. individual review (Haubrock, 2018d; Kronz, 2005; Preissler, 2008)
- internal vs. external ratios (Haubrock, 2018d; Reichmann, et al., 2017; Preissler, 2008).

In terms of the selection of KPIs, several aspects are indicated to be essential:

- the determination of the important and relevant KPI perspectives based on/interlinked with the given strategy and the adequate number of KPIs considering the cost-benefit ratio (Burkert, 2008; Gladen, 2014; Kappler, 2010; Kirstein & Lurati, 2017; Marr, 2012; Parmenter, 2015; Preissler, 2008; Salfeld, et al., 2009; Staehle, 1969)

- the assurance of the precise quantifiability and adequate measure cadence (Haubrock, 2018d; Parmenter, 2015; Preissler, 2008; Reichmann, et al., 2017; Staehle, 1969; VDI, 1999; Zapp, 2010)
- the definition of at least one accountable person per KPI result who can influence the development of the ratio (Kappler, 2010; Preissler, 2008; Salfeld, et al., 2009)
- the focus on persistence (transparent and comprehensive cause-effect relationship) (Kappler, 2010; Mauboussin, 2012; Salfeld, et al., 2009; WGKT-Empfehlung, 2009)
- to ensure senior management acceptance of KPIs (Kirstein & Lurati, 2017; Parmenter, 2015)

In order to secure the quality of KPIs, literature suggests ensuring the

- correct and explicit determination of the measuring point(s) and the calculation procedure including the minimization of the risk of manipulation (Burkert, 2008; DIN, 1996; Gladen, 2014; Kronz, 2005; Preissler, 2008; Staehle, 1969; WGKT-Empfehlung, 2009)
- currency of KPIs (Burkert, 2008; DIN, 1996; Kappler, 2010; Parmenter, 2015; Preissler, 2008; WGKT-Empfehlung, 2009)
- user-friendliness of KPIs (adequate KPIs and understandability) and tailored reporting (Parmenter, 2015; Preissler, 2008).

When applying and interpreting KPIs, the following aspects should be considered:

- the analysis and discussion of the adequacy and purposefulness of the chosen KPIs and results on the different levels (Botta, 1997; Hess, 2005; Marr, 2012; Staehle, 1969; WGKT-Empfehlung, 2009)
- the assurance of the full understanding of the KPIs, their correct interpretation together with the derivation of appropriate action being aware that the existence of a KPI itself does not change anything (Burkert, 2008; DIN, 1996; Haubrock, 2018d; Health Information and Quality Authority, 2013; Marr, 2012; Parmenter, 2015; Preissler, 2008; Staehle, 1969)
- the consideration of the relationships and interlinks between the KPIs in quantitative and qualitative perspectives and combinations (Botta, 1997; Burkert, 2008; DIN, 1996; Haubrock, 2018d; Hess, 2005; Parmenter, 2015; Preissler, 2008; Reichmann, et al., 2017; Staehle, 1969; Zapp, 2010).

In terms of KPI reporting, Gluchowski et al. (2008) indicate aligning the following aspects to provide appropriate and useful KPI reporting:

- Reporting purpose (documentation, decision support, process operation, monitoring/early diagnosis
- Reporting content (context, degrees of scope, details and accuracy)
- Reporting form (presentation, structure, medium, channel)
- Reporting time (intervals and periods)
- Reporting instance (addressee, responsible manager, creator).

According to Bange (2013) and Gluchowski et al. (2008), typical reporting uses are

- standard reporting (periodical, static representation on paper or screens)
- ad-hoc reporting (dynamic interactive navigation in a pre-defined data set)
- analysis (ad-hoc reporting with additional functionalities to independently exploratively analyse a data set)
- simulations and forecasting (calculation of future and/or possible scenarios combining different data sets).

Whenever reporting is done in a dynamic, interactive manner, a corresponding representation and visualisation of data is necessary (Apel, n.d.; Bange, 2013; Capone, 2015; Cotton, 2010; Hess, 2005; Möller, et al., 2011; Orts, 2005). Common possibilities are management cockpits / dashboards or Business Intelligence (BI) portals – either as standard, customized or in-house developed software (cf. subsection

2.3.4.2). The main goal of management cockpits/dashboards and BI portals is to effectively and efficiently support management and decision makers by visualizing data in the specific and necessary manner and allowing data processing for the necessary purpose (Apel, n.d.; Bange, 2013; Capone, 2015; Cotton, 2010; Hess, 2005; Möller, et al., 2011; Orts, 2005).

This thesis is based on the conviction that for KPI calculation and reporting, ICT has a vital role to play in order to assess the functional, quality, technical and organisational requirements, to ensure the information logistics (adequate amount of correct data in the adequate quality at the adequate place/in the adequate medium in an adequate form at the right time for the right recipient) and to guide prioritisation of KPI reporting implementation in terms of urgency, cost, time and benefit-/risk ratio (cf. section 2.3) (Health Information and Quality Authority, 2013; Hess, 2005; Neri, 2013; Reichmann, et al., 2017).

2.4.2 Key Performance Indicators (KPIs) and Reporting in Hospitals

The described basis about KPIs also applies for hospitals. What is special for hospitals – and in Switzerland in particular – is that the application of business administration tools, controlling principles and thus the use of KPIs is relatively new compared to other industries or other countries, however gaining importance by current developments as discussed in subsection 2.1.2 (Gerber, et al., 2017a; Kappler, 2010; Kirstein & Lurati, 2017; pwc, 2016; Rohner, 2013; Salfeld, et al., 2009; Thiex-Kreye, 2009; Zapp, 2010).

The definition, collection, analysis and discussion of KPIs in hospitals faces the challenge that, due to the fact that there is still little experience in performance measurement in hospitals, appropriate holistic KPI systems taking into account the complex interdependencies between different medical and non-medical aspects and influencing factors have not yet been widely established and the reporting infrastructure is still behind other industries, still dealing with a substantial amount of unsystematically, manually collected data (cf. subsection 2.1.2) (Kirstein & Lurati, 2017; Mettler & Rohner, 2009; Raphael, 2013; Rohner, 2013; WGKT-Empfehlung, 2009; Zapp, 2010). However, several authors point out the necessity and importance of developing a KPI culture in hospitals, not only listing typical static and medical-focused KPIs (e. g. numbers of beds, cases or clinics, Case-Mix-Index, Baserate, proportion of trained staff, patient waiting time, average duration of stay, patient satisfaction, complication and mortality rates), but including the non-medical KPI perspective and combining them in a dynamic manner and considering the important interdependencies between them (Gerber, et al., 2017a; Gräber, et al., n.d.; Health Information and Quality Authority, 2013; Raphael, 2013; Reuschl & Bouncken, 2014; Salfeld, et al., 2009; Thiex-Kreye, 2009; Zapp, 2010). In terms of non-medical support services (cf. subsection 2.4.2), Gerber et al. (2017a) present a KPI catalogue as a framework, contributing to the development of the context, however not dealing with the specific implementation. For the development of a holistic and hospital-wide KPI culture, including the above-mentioned aspects about KPI selection, calculation and analysis, the Health Information and Quality Authority (2013), Kirstein and Lurati (2017), Mettler and Rohner (2009) and Rohner (Rohner, 2013)mention the following aspects as success factors within the process:

- an intense top management involvement and communication
- a close collaboration and dialogue with the end-users about KPI selection and reporting style and frequency
- an explicit patient focus
- allowing sufficient time for planning and setup of the KPI introduction
- rather fewer than too many KPIs to start with

- the inclusion of quality control and extensive tests to insure the defined and necessary quality of the KPIs
- a deliberate development of transparency and allowance to make and learn from mistakes
- a continual improvement process

For the model development in this thesis, the KPIs suggested in the KPI Catalogue for Non-medical Support Services in Hospitals by Gerber et al (2017a) for the 15 non-medical support services in hospitals illustrated in Figure 8 and the success factors for introducing KPI reporting in hospitals according to Quality Authority (2013), Kirstein and Lurati (2017) and Mettler and Rohner (2009) are used as a basis.

2.5 Stakeholders and Stakeholder Management in General, in Hospitals and in Information Systems Management in Hospitals

In this section, the context of stakeholders and stakeholder management in general, in hospitals and specifically in information systems management in hospitals will be outlined. The context of the topic is schematically illustrated in Figure 13.

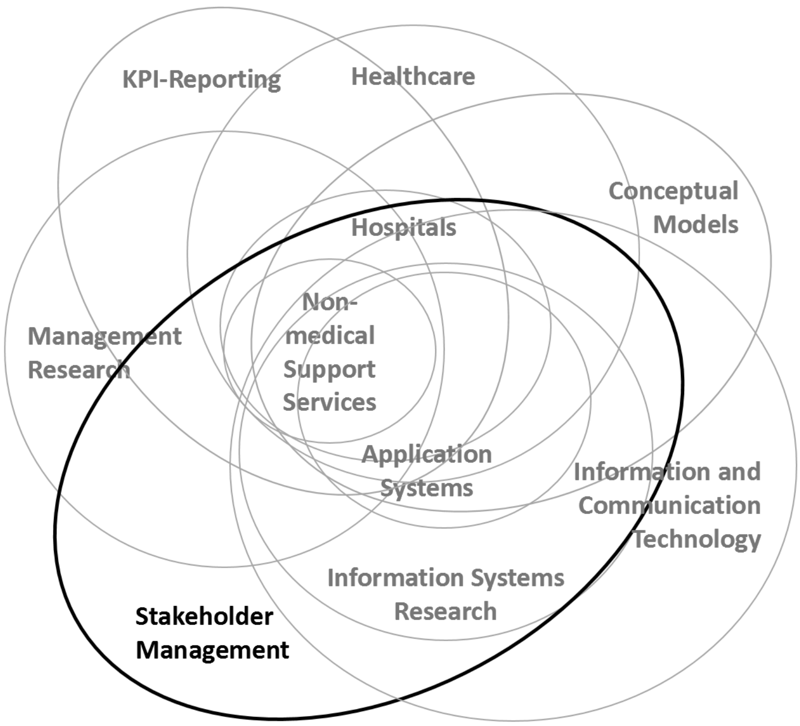

Figure 13: Stakeholder Management as part of the conceptual background chapter in this thesis based on Gerber (2018)

2.5.1 Stakeholders and Stakeholder Management in General

The term “stakeholders” is commonly defined as

- individuals, groups, organisations or entities
- being (directly, indirectly or potentially) affected by activities of an organisation or project and
- (directly, indirectly or potentially) influencing an organisation or project

(Blair, 1998; Freeman, 2010; Lehmann, 2016; Schmidt, 2011; Wheeler & Sillanpää, 1998). According to Bourne, (2009, p. 31), what can be at stake is

- “Interest […]
- Rights […]
- Ownership […]
- Knowledge […]
- Impact or influence […]
- Contribution”

Pouloudi (1998, p. 103) defines the following principles of stakeholder behaviour:
“1. The set and number of stakeholders are context and time dependent
2. Stakeholders are interrelated
3. A stakeholder’s role may change over time
4. Stakeholders may have multiple roles
5. Different stakeholders may have different perspectives and wishes
6. The viewpoints and wishes of stakeholders may change over time
7. Stakeholders may be unable to serve their interests or realise their wishes”.

Since the appearance of the term “stakeholder” in the 1960s (Freeman, 2010), the importance of an active management of stakeholders has been emphasized, underpinned by ethical, public or corporate public relations policies and/or for resource and risk management reasons ensuring target achievement and success (Bourne, 2009; Lehmann, 2016; Savage, et al., 1991; Schmidt, 2011; Wheeler & Sillanpää, 1998). Managing stakeholders means to know

- who the stakeholders of a specific endeavour are,
- what their role is in the context of the specific endeavour and
- how to communicate with stakeholders

with the goal to appropriately react to potential problems in order to

- prevent negative impact, damage and/or cost by stakeholder (re)actions,
- ensure success and/or maximum outcome of an endeavour and
- detect potential opportunities

(Blair, et al., 2002; ISO 21500-2013, 2013; Lehmann, 2016; Martinelli & Milosevic, 2016; Sharp, et al., 1999; Wheeler & Sillanpää, 1998). In order to be successful in stakeholder management, Scholes and Clutterbuck (1998, p. 235) suggest to

- “Listen
- Inform
- Manage agreement/disagreement
- Learn together
- Influence and be influenced.”

Further stakeholder management principles encompass

- the inclusion of different perspectives
- the awareness of mutualities, power games and competing agendas
- the acceptance of changeability
- adequate communication
- ensuring the necessary competencies and commitments from management

(Blair, et al., n.d.; Blair, 1998; Bourne, 2009; Freeman, 2010; Martinelli & Milosevic, 2016; Pouloudi, 1998; Savage, et al., 1991).

In literature, there are different approaches and understandings about stakeholder management methodologies. In general, the following steps can be made out:

- Step 1 – Identification of stakeholders:

The purpose of stakeholder identification is to have the knowledge of preferably all but at least the most important stakeholders for which specific, effective actions can be determined (Bourne, 2009; ISO 21500-2013, 2013; Martinelli & Milosevic, 2016). Stakeholders have to be identified on all possible levels and bearing in mind different perspectives:

  - an internal and external view
  - the economic, technological, political, social and managerial context
  - the primary and secondary context

(Bourne, 2009; Freeman, 2010; ISO 21500-2013, 2013; Pouloudi, 1998; Project Management Institute, 2017; Wheeler & Sillanpää, 1998). Bearing in mind the stakeholder principles described in subsection 2.5.1, it becomes clear how difficult the identification of stakeholders can be. Pouloudi (1998) therefore suggests to repeatedly review the stakeholder list and maps and to include different perspectives and approaches (cf. also step 4).

- Step 2 – Analysis and prioritization of stakeholders:

The purpose of analysing stakeholders is to know about their viewpoint, perception, position, attitude, expectation, interest, proximity, power, allegiance, engagement, feeling of urgency, obligation, concern, fear, aspiration and hope in or towards the concerned endeavour (Bourne, 2009; Freeman, 2010; Martinelli & Milosevic, 2016; Pouloudi, 1998; Savage, et al., 1991; Schmidt, 2011; Scholes & Clutterbuck, 1998). The goal is to reach an understanding of the gathered information, to interpret the significance of information pieces as well as to recognize mutualities and relationships, risks and opportunities and thus to choose the adequate measures and communication strategy for each stakeholder group (Bourne, 2009; Martinelli & Milosevic, 2016; Schmidt, 2011; Sharp, et al., 1999). Analysing and prioritizing stakeholders means

- the documentation of each stakeholder
- the categorization / structuration / visualization / mapping of stakeholders
- prioritization of stakeholders
- setting up a stakeholder management plan
- the derivation of necessary action

(Bourne, 2009; Martinelli & Milosevic, 2016; Schmidt, 2011; Sharp, et al., 1999). Due to the dynamic factor in the stakeholder management context, it is important to mention the need for repeated re-analyses (Martinelli & Milosevic, 2016; Pouloudi, 1998).

- Step 3 – Influencing stakeholders and stakeholder relationships:

Different frameworks about influencing and managing stakeholders are available in literature. Bourne (2009) presented a targeted communication framework with the main goal to influence the attitude, emphasizing the importance of respecting the aspect of power, proximity and urgency, pointing out the importance of not only being aware of choosing the adequate leadership style but also the appropriate direction of influence in order to effectively manage relationships. Lehmann (2016) developed a stakeholder attitude influence chart, Savage et al. (1991) a framework for transforming typical stakeholder relationships, the Project Management Institute (2017) a framework including planning and managing stakeholders, Scholes and Clutterbuck (1998) 6 steps to an integrated stakeholder approach and Wheeler and Sillanpää (1998) a generalized cycle of inclusion for stakeholders. Martinelli and Milosevic (2016) and Pouloudi (1998) emphasize the need for iterative modifications also in this phase.

- Step 4 – Monitoring stakeholder engagement:

As mentioned in previous steps and particularly within Pouloudi's (1998) stakeholder principles, stakeholders and stakeholder relationships are dynamic in a number of ways. Therefore, the stakeholder situation has to be monitored and the identification, analysis and influencing measures have to be re-assessed and modified as necessary (Bourne, 2009; Project Management Institute, 2017; Savage, et al., 1991).

In this thesis, the four above-mentioned stakeholder management steps
Identification of stakeholders (step 1)
Analysis and prioritization of stakeholders (step 2)
Influencing stakeholders and stakeholder relationships (step 3)
Monitoring stakeholder engagement (step 4)
consolidated from Bourne (2009), Freeman (2010), ISO 21500-2013 (2013), Lehmann (2016), Martinelli and Milosevic (2016), Pouloudi (1998), Project Management Institute (2017), Savage et al. (1991), Schmidt (2011), Scholes and Clutterbuck (1998), Sharp et al. (1999) and Wheeler and Sillanpää (1998) were chosen as a basis for the development of the model.

2.5.2 Stakeholders and Stakeholder Management in Hospitals

According to Blair et al. (n.d.) and Fottler et al. (1989), hospital stakeholders can be divided into three groups:

- external stakeholders (providing inputs to, competing with or having special interests in the organisation)
- interface stakeholders (operating internally and externally of the organisation)
- internal stakeholders (operating within the organisation)

In Table 2, specific examples are listed.

Table 2: Stakeholders in hospitals based on Blair et al. (n.d.), Braun von Reinersdorff (2007), DIN 13080 (1999), Flessa (2014), Fottler et al. (1989), Johner (2016) and Kriegel (2012)

Stakeholder group	**Specific examples**
External stakeholders	patients, dependants, referrers, competitors, government, elected public officials, political pressure groups, private accreditation associations, professional associations, unions, insurers, third-party payers, financial community / banks / investors, sponsors, suppliers, special interest groups, religious organisations, media, local community, society
Interface stakeholders	hospital board (of trustees), parent companies, stockholders / taxpayers / contributors, related health care organisations
Internal stakeholders	different occupational groups: examination and treatment, care, administration, social services, supply and disposal, research and development, management (top, medical, nonclinical, clinical functional, clinical product line), non-management employees (professionals, paraprofessionals, support personnel)

Haux et al. (2010, p. 167) list different stakeholders with their specific information expectations:

- "Patient: Availability of up-to-date medical knowledge gives the staff more time for the patient, as they don't waste time on unnecessary documentation tasks or inflexible information processing tools.
- Relatives: The patient can easily be found in the hospital, and information for home care is made available.

- Physicians: Test results are available on the physician 's rounds, so that no time is lost with insufficiently designed information processing tools. Multiple usability of data, the availability of the whole patient record, simple and standardized forms for data entry, and access to new medical knowledge are important.
- Nurses: Easy procedures for scheduling and order entry, availability of bedside documentation tools, support of ward organisation, and easy access to nursing guidelines and to nursing knowledge are provided.
- Administrative staff: Up-to-date administrative information and efficient tools to support billing and financial budgeting are available.
- Hospital management: Easy access to complete and up-to-date information on the quality of patient care and on its costs is provided."

Stakeholder management in the hospital context has become more important and more demanding within the last years, leading to a significant need for corresponding stakeholder management competencies of hospital managers including the awareness of different stakeholder management styles in order to handle the even growing complexity and diversity of hospital stakeholders in a dynamic context as discussed in subsection 2.1.2.4 (Blair, et al., 2002; Blair, et al., n.d.; Braun von Reinersdorff, 2007; Fichman, et al., 2011; Fottler, et al., 1989). The stakeholder management methodologies mentioned in subsection 2.5.1 generally also apply to the healthcare context. However, Braun von Reinersdorff (2007) mentions a few healthcare context particularities:

- in healthcare, the differentiation between shareholders and stakeholders is not always clear, depending on the specific legal and political structures and circumstances; this fact leads to difficult decision making processes
- in healthcare, the different forms of political, private or combined financing concepts distorts competition and the relationships between the stakeholders within this context
- in healthcare, there is a potential lack of transparency of strategic ambitions due to the coexistence of altruistic and opportunistic motives
- in healthcare, there is a common co-existence of competition and cooperation amongst stakeholders or stakeholder groups.

Blair et al. (n.d.) and Blair et al. (2002) present a Stakeholder Relationship Diagnosis Framework to assess four types of stakeholder relationships in the healthcare context:

- the mixed blessing stakeholder relationship
- the supportive stakeholder relationship
- the non-supportive stakeholder relationship
- the marginal stakeholder relationship.

For the development of the model in this thesis, internal, interface and external stakeholders were considered to be important to be taken into account.

2.5.3 Stakeholders and Stakeholder Management in Information Systems in General and in Hospitals in Particular

Stakeholder management issues in the context of ICT and information systems are, according to Kamal et al. (2010), Mishra and Dwivedi (2012), Moturi et al. (2013) and Sharp et al. (1999)

- to integrate an ethical user-centred perspective

- to apply a holistic, organisation-wide stakeholder integration and involvement, particularly for requirements engineering
- to foster collaboration between developers and stakeholders throughout projects.

Focusing on the stakeholder involvement in the specific context of hospital ICT projects, Mantzana and Themistocleous (2005) present a “Conceptual Model for Healthcare Actors Identification” including a list of specifically identified stakeholder groups – gained in the context of Enterprise Application Integration projects in the healthcare sector:

- Patients
- Next of Kin
- Clinicians
- Non-clinicians
- Clinical Students
- Hospitals
- Medical Clinics
- Administrators
- Legal Professionals
- Researchers
- Suppliers
- Technologists
- Insurance Companies
- Managers
- Government
- Health Authorities

In this thesis, the research subjects are stakeholders in the context of the selection, generation and reporting of KPIs for non-medical support services in hospitals. Therefore, the “Conceptual Model for Healthcare Actors Identification” by Mantzana and Themistocleous (2005) was chosen as a conceptual basis.

2.6 Conceptual Models

In this section, the context of models in general and in the specific context of Business and Management (Research) and Information Systems (Research) is presented – particularly focusing on metamodels, reference models and procedure models. Figure 14 illustrates the section within the whole conceptual basis chapter.

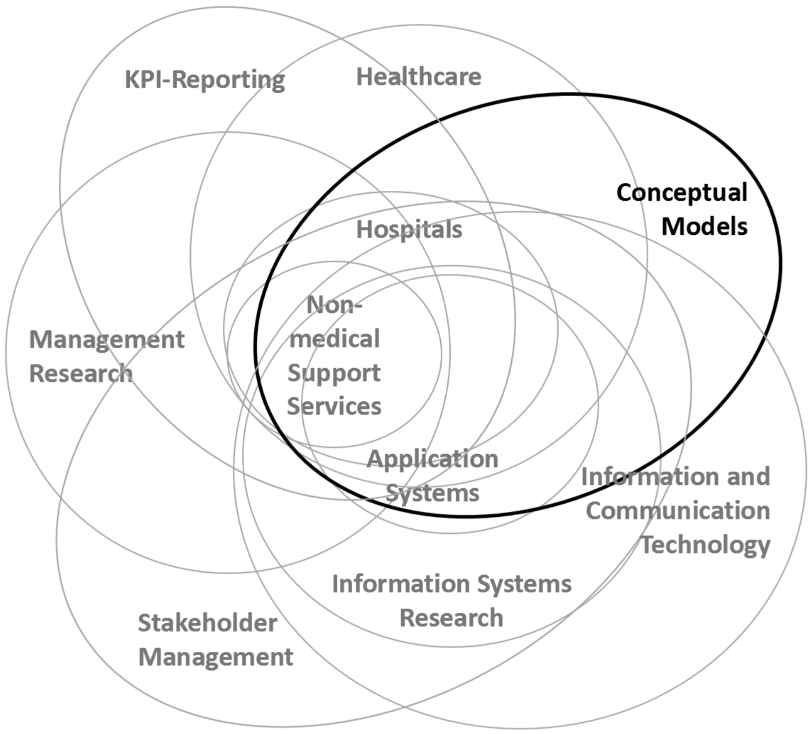

Figure 14: Models as part of the conceptual background chapter in this thesis based on Gerber (2018)

2.6.1 Introduction to Models

According to Stachowiak (1973) – one of the pioneers in the model theory and model concept development – the word "model" stems from the Latin word "modulus" which stood for measurement, standard, kind, manner, form, specification. The translation and lore of the word "model" led to the situation that the term "model" can have multiple features

- imaging feature: models are representations of natural or artificial originals
- reductionist feature: models do not represent all attributes but only the ones relevant to the context
- pragmatic feature: models serve the purpose of specific subjects, within a specific time, with the restriction of certain limitations and are thus not principally assignable to their originals.

According to DIN (2000), models are constructs of a modeller trying to fulfil a specific goal. Goals of models can be

- the documentation and explication of systems and circumstances (Becker, et al., 2012; EABPM, 2014; Grochla, 1974; Pidd, 2009)
- the generation of a basis for a general understanding of a context and further discussions (Bernard, et al., 2017; EABPM, 2014; Joosten, 2000; Kruse, 1996; Müller & Johner, 2009; Pidd, 2009)
- the abstraction of real-world context in order to reduce complexity and to enhance manageability (Banks & Nelson, 2014; Bernard, et al., 2017; DIN, 2000; Grochla, 1974; Pidd, 2009; Prilla, 2010)
- the demonstration and virtualization of logic connections and relationships (EABPM, 2014; Goeken, 2003; Prilla, 2010)
- the simulation of scenarios and/or hypotheses as a basis for changing and impacting the system in the real-world (Becker, et al., 2012; EABPM, 2014; Hars, 1994; Grochla, 1974; Hars, 1994; Kruse, 1996; Pidd, 2009)

- the fulfilment of a specific purpose for specific stakeholders by containing only the necessary elements for this purpose or these stakeholders (Becker, et al., 2012; Frank, et al., 2014; Haux, et al., 1998; Prilla, 2010; vom Brocke, 2003).

Models can be classified as listed in Table 3.

Table 3: Model typologies

Descriptive model a description model representing an already existing segment of reality; character of inventory (BusinessDirectory.com, n.d.b; Delfmann, 2006; Grochla, 1974; Rosemann, 1996)	**Normative model** a design model constructed to influence the reality towards an ideal state (BusinessDirectory.com, n.d.d; Delfmann, 2006; Grochla, 1974; Rosemann, 1996)
Deterministic model model with unambiguous relationships and (known) estimates for each variable (Grochla, 1974; BusinessDirectory.com, n.d.c)	**Stochastic model** model with ranges of (random) variables (BusinessDirectory.com, n.d.e; Grochla, 1974)
Abstract-symbolic model linguistic model of natural or artificial language (Grochla, 1974)	**Iconic-illustrated model** illustration of the real-world object (Grochla, 1974)
Explanatory model model explaining a specific context or phenomenon in an explicative way (Grochla, 1974; Wirtschaftslexikon24.com, 2018b)	**Decision model** model supporting the decision making based on predictions (BusinessDirectory.com, n.d.a; Grochla, 1974; Wirtschaftslexikon24.com, 2018a)
Logic-based model model representing logical structures, forms and principles of thinking (Hars, 1994)	**Graph-based model** model comprising graphical representations enabling the structuring of knowledge (EABPM, 2014; Grochla, 1974; Hars, 1994; Prilla, 2010)
Semantic model model using terms/semantics from the modelled context (Speck, 2001)	**Conceptual model** model using a conceptual language to display the context (Speck, 2001)
Static model model representing a context at a specific point in time (Banks & Nelson, 2014; EABPM, 2014; Grochla, 1974; Kruse, 1996)	**Dynamic model** model showing changes over time; simulations. (Banks & Nelson, 2014; EABPM, 2014; Grochla, 1974; Kruse, 1996)
Mathematical model model with symbolic notation and mathematical equations (Banks & Nelson, 2014; EABPM, 2014)	**Physical model** model representing an object in a different scale (Banks & Nelson, 2014; EABPM, 2014)

It becomes evident that not only the term “model” itself has been used and interpreted differently, but also the understanding of their construction and implementation, depending on the context and/or their purpose (Grochla, 1974; Schütte, 1998; Thalheim & Tropmann-Frick, 2016; Thomas, 2006a). Pidd (2009) however points out to keep in mind that models are always limited as they are simplifications and approximations.

Due to the research domain described in subsection 1.1.2, this thesis focuses on models in the context of Business and Management (Research) as well as Information Systems (Research).

2.6.1.1 Models in Business and Management (Research) and Information Systems (Research)

The use of models in Business Administration started in the 1960s and became common as of the 1970s (Pidd, 2004; Schütte, 1998). Since the 1980s, more interactive possibilities of creating and applying models have become possible due to the developments in ICT. Thus, this aspect has become even more important, both in Business (Research) and in Information Systems (Research) (Braun, et al., 2007; Maier, 1996; Schlagheck, 2000; Pidd, 2004; Pidd, 2009). In Business and Management (Research) and Information Systems (Research), the main goal for the application of (conceptual) models is to

- support and improve decision-making and/or
- foster knowledge management, change management and/or human resource management and thus
- control organisations and the associated resources in an optimal manner

(Becker, et al., 2012; Fettke, 2009; Maier, 1996; Pidd, 2009; Schütte, 1998).

When talking about models in the Business and Management (Research) or Information Systems (Research) context, commonly

- an immaterial, abstract, simplified, typically graphical, cognitive
- representation, (re-)construction or interpretation of
- elements (tangible or intangible things), their relationships, properties and behaviour of a real-life context or system at a specific point in time
- including different levels representing different degrees of abstraction (the (meta)meta level defining the conditions of the models (cf. subsection 2.6.2.1) and the model level, presenting the model itself)

is understood (Banks & Nelson, 2014; Becker, et al., 2012; Delfmann, 2006; Goeken, 2003; Hars, 1994; Haux, et al., 1998; Kruse, 1996; Müller, 1983; Prilla, 2010; Rosemann, 1996; Schütte, 1998; Volz, 2011; vom Brocke, 2003). The understanding of models in Business (Research) and Information Systems (Research) thus corresponds to the definition of conceptual models according to Frank (2000a), Frank (2007a), Frank et al. (2007), Frank et al. 2014 (Frank, et al., 2014), Shanks et al.(2003) Wand et al. (1995).

In this thesis, due to the context of the research background, research domain and research problem (cf. section 1.1 et seq.), the understanding of models corresponds to the definition of conceptual models according to Frank (2000a), Frank (2007a), Frank et al. (2007), Frank et al. (2014), Shanks et al. (2003) and Wand et al. (1995) and can be summarised as immaterial, abstract, simplified, graphical, cognitive representations, (re-)constructions or interpretations of elements (tangible or intangible things), their relationships, properties and behaviour of a real-life context or system at a specific point of time including different levels representing different degrees of abstraction.

2.6.2 Model Types in Business and Management (Research) and Information Systems (Research)

In order to choose the appropriate model type, it is important to determine the purpose of the model and thus the relevant model perspective. In Business and Management (Research) and Information Systems (Research), according to Becker et al. (2012) and Scheer (2002) the most common modelling perspectives are the

- functional view
- organisational/structural view

- data view
- performance view
- control/process view.

Based on typical model perspectives in Business and Management (Research) and Information Systems (Research) mentioned above, common models of this context are

- metamodels
- reference models
- process models
- procedure models
- information models
- data models
- enterprise models

which will be described in detail in the following subsections.

2.6.2.1 Metamodels

Metamodels can be defined as follows:

- Metamodels are abstract systems which form the theoretical basis by defining the syntax of the corresponding models, specifying the modelling rules for the constructs, structures, elements, objects, attributes, functions and relationships as well as the model layout of the corresponding models – a metamodel is thus a model of a model (Becker, et al., 2012; DIN, 1996; Gemino & Wand, 2003; Mendling, et al., 2007; Volz, 2011).
- Every metamodel is based on a metamodel, which can be represented by itself (Rosemann, 1996).
- Metamodels are usually more abstract than their related models and thus usually don’t include business operation knowledge but methodological knowledge (Gemino & Wand, 2003; Hars, 1994).
- A model is an instance of a metamodel and every metamodel is based on a metamodel which can be the meta-metamodel or the metamodel itself as illustrated in Figure 15 (Rosemann, 1996; Volz, 2011; Winter, et al., n.d.).
- The goal of metamodels is to avoid homonyms or synonyms (Becker, et al., 2012; DIN, 1996).

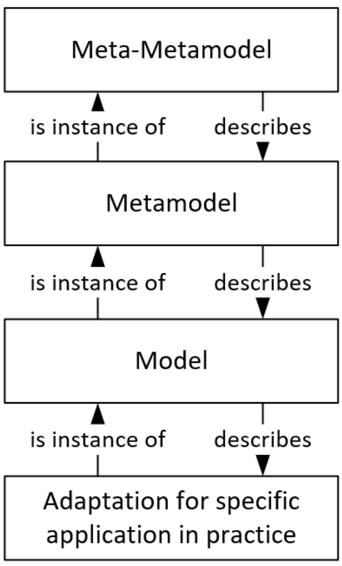

Figure 15: Levels of models based on Volz (2011, pp. 25-27)

The models based on the metamodels therefore have to completely correspond with the metamodels in order to be syntactically (formally) correct (DIN, 1996; Gemino & Wand, 2003; Rosemann, 1996). For constructing metamodels, different notations can be used. Mendling et al. (2007) list Entity Relationship Diagrams, Unified Modeling Language (UML) class diagrams, graphs or Extensible Markup Language (XML) schemata as examples (cf. 2.6.3).

In this thesis, a metamodel is understood as an abstract system forming the theoretical basis defining the syntax of the corresponding models, specifying the modelling rules for the constructs, structures, elements, functions, object and model attributes as well as the model layout and relationships according to Becker et al. (2012), DIN (1996), Gemino and Wand (2003), Mendling et al. (2007) and Volz (2011) and therefore being an inherent component of the reference model to be developed in order to reach this thesis' research aim (cf. subsection 1.3.1).

2.6.2.2 Reference Models

In literature, there is no consistent understanding of the definition or classification of reference models. Often, a reference model is described as a model which – in a specific context or domain –

- can be referred to
- offers a framework
- can be reused
- has a certain universality
- can be adapted
- is applicable
- documents knowledge
- can be located on different levels of abstractions

(Delfmann, 2006; Fettke & Loos, 2004a; Fettke & Loos, 2004c; Fettke & Loos, 2006; Frank, et al., 2007; Hars, 1994; Kruse, 1996; Maicher, 1999; Scheer, 1999; Schlagheck, 2000; Schmincke, 1997; Schütte, 1998; Thomas, 2006b; Thomas, 2006a; Thomas, 2007; vom Brocke, 2003; vom Brocke & Fettke, 2018; Winter & Schelp, 2006).

Reference models can be very comprehensive or rather small (EABPM, 2014; Fettke & Loos, 2004c; Fettke & Loos, 2007; Scheer & Nüttgens, 2000) and can be developed for any model type, e. g. as

- process reference model (Fettke, et al., 2006; Scheer & Nüttgens, 2000; Schütte, 1998; Winter & Schelp, 2006)
- software reference model (DIN, 2000; Fettke & Loos, 2004c; Reiter, 1999; Scheer, 2002; Scheruhn, 1997; Seubert, 1997; vom Brocke, 2003; Winter, et al., 2005; Winter, et al., n.d.)
- organisational reference model (DIN, 2000; Winter, et al., 2005)
- information reference model (Becker, et al., 2002; Schütte, 1998; Winter, et al., 2005; Winter, et al., n.d.)
- procedure reference model (DIN, 2000; Thomas, 2006a; Winter, et al., 2005; Winter, et al., n.d.)

or, focusing on a specific branch or industry, as industry reference model (Reiter, 1999; Scheruhn, 1997; Schmincke, 1997) or additionally, including several dimensions to be included and interlinked, as multi-perspective reference model (Becker, et al., n.d.; Delfmann, 2006; Fettke & Loos, 2004c; Rosemann & Schütte, 1999; vom Brocke, 2003). According to Heslenfeld (2007), specific examples of reference models are the Information Technology Infrastructure Library ITIL (Ebel, 2015) or the OSI Reference Model (Stöttinger, 1989). Reference models can therefore be developed in different notations, depending on the specific context and purpose (Schlieter, et al., n.d.; Schütte, 1998). Typical reference model notations are Entity-Relationship-Model Notation (ERMN), Unified Modeling Language (UML), Object Modeling Technique (OMT), Event Driven Process Chain Notation (EPC), Semantic Object Model (SOM) or Function Trees (Fettke & Loos, 2004b; Fettke & Loos, 2004c; Fettke & Loos, 2007; Scheer, 2001; Schlagheck, 2000; Schlieter, et al., n.d.) (cf. subsection 2.6.3).

The goals and/or benefits of a reference model application are:

- the reduction of implementation time and thus the reduction of cost (Becker, et al., 2012; Fettke & vom Brocke, 2013; Frank, et al., 2007; Hars, 1994; Kruse, 1996; Scheer, 2002; Schütte, 1998; Thomas, 2006a)
- the support for and acceleration of the construction of specific models or systems (DIN, 1996; Fettke & Loos, 2003c; Schütte, 1998; Thomas, 2006a; vom Brocke, 2003)
- the help to choose, customize and/or integrate standard software (Delfmann, 2006; DIN, 2000; Frank, et al., 2007; Schütte, 1998)
- the potential improvement of quality (DIN, 2000; Fettke & vom Brocke, 2013; Frank, et al., 2007; Hars, 1994; Kruse, 1996)
- the possibility to systematize and transfer knowledge (Delfmann, 2006)
- the reduction of risk (Fettke & vom Brocke, 2013; Hars, 1994; Schütte, 1998).

To reach these goals, the following aspects have to be taken into consideration:

- The reference model has to be adapted to the specific context and requirements (Fettke & Loos, 2003b; Fettke & Loos, 2004c; Scheer & Nüttgens, 2000).
- The end user must be involved in the development and specification (Frank, et al., 2007; Höhnel, et al., 2007).
- The context, the principles, the model itself, the changes and the application of the reference model must be documented (Braun, et al., 2007; Höhnel, et al., 2007; Thomas, 2006a).
- The quality must be ascertained (Fettke & Loos, 2003a; Scheer, 1999; Schütte, 1998).
- The application of the reference model should be supported by adequate tools (Höhnel, et al., 2007).
- The reference model to be applied must be thoroughly assessed and chosen adequately for the intended purpose (Höhnel, et al., 2007).

The research aim of this thesis is to develop a reference model providing the necessary information about a standardized procedure and its significant aspects for aligning non-medical support service applications in hospitals so that relevant KPIs for systematic controlling and optimization can be generated and configured as a decision basis for managers (cf. subsection 1.3.1). Based on DIN (2000), Frank (2007a), Frank et al. (2007), Fettke and Loos (2003b), Fettke and Loos (2006), Fettke and Loos (2007), Scheer and Nüttgens (2000), Seubert (1997), Winter et al. (n.d.) and Winter and Schelp (2006), the understanding of a reference model in this thesis is a generic, idealized conceptual framework that formalizes recommended (best) practices for the domain of non-medical support service applications in hospitals, with the goal to give adequate orientation and to encourage the understanding and dialogue between different stakeholders in this context.

2.6.2.3 Procedure Models

> A *procedure* is a collection of activities, rules that govern the order of events in those activities, and rules that identify the responsibilities of people involved, all of which belong together for the sake of realizing a specific commitment among the stakeholders in the context of a business process.

(Joosten, 2000, p. 292)

Procedure models are thus models showing the sequences or groups of activities in order to proceed effectively in terms of time and content within an (ICT) project or task (Allweyer, 2012; Breitner, n.d.; Delfmann, 2006; Seibt, 2001). A procedure model is structured in plannable and – with the means of measurable milestones – controllable phases or steps defined by several specific activities to be executed by specified responsible people in order to reach (partial) outputs (Allweyer, 2012; Seibt, 2001). Activities in procedure models can be conducted sequentially or in parallel; phases, steps or activities can be iterative if necessary (Seibt, 2001). According to Allweyer (2012) in Business and Management and Information Systems (Research), procedure models are typically applied in the development and construction of products, software development or business process optimization. However, Allweyer (2012) emphasizes that every procedure model has to be adapted to the respective context. Seibt (2001) points out that particularly in IS procedure models, the implementation phase should be shown in detail not only focusing on technical aspects but considering the socio-technical human-machine-relationship.

According to Breitner (n.d.) procedure models are often classified as reference models, e. g. PRINCE2 (n.d.) or V-Modell (2006) for the development of information and application systems, the Information Technology Infrastructure Library ITIL for ICT service management (Ebel, 2015) or the EFQM-model for Quality Management (EFQM, n.d.). The general goals of procedure models are the systematic planning, controlling and monitoring of projects (in particular for the development of information and application systems as well as software and business process re-engineering) (Allweyer, 2012; Breitner, n.d.; Seibt, 2001).

The empirical analysis of the second iteration of the “Theorising” phase (cf. subsection 4.1.2.7) and the first iteration of the “Building” phase (cf. subsection 4.2.2) led to the conclusion that a procedure model is a suitable model type to reach the research aim (cf. subsection 1.3.1). In this thesis, a procedure is understood, based on Joosten (2000, p. 292), as […] “a collection of activities, rules that govern the order of events in those activities, and rules that identify the responsibilities of people involved, all of which belong together for the sake of realizing a specific commitment among the stakeholders in the context of a business process” and a procedure model as model, structured in plannable phases or steps, showing the sequences or groups of activities which can be conducted sequentially or in parallel and/or iteratively, considering the socio-technical aspects of the context according to Allweyer (2012), Breitner (n.d.), Delfmann (2006) and Seibt (2001).

2.6.2.4 Process Models

Process models enable different specific views, aspects, concepts or activities of processes with the goal to

- increase transparency and manageability of process steps and/or
- control an institution and/or
- document process knowledge and/or
- ensure quality and/or
- analyse and increase effectiveness and efficiency and/or
- help to enable process simulations and/or
- develop or choose software and/or

- enable (semi-)automatize process execution

(Becker, et al., 2000; Becker, et al., 2012; EABPM, 2014; Kruse & Scheer, 1992; Prilla, 2010; Rosemann, 1996; Scheer & Nüttgens, 2000; Scheer, 2002).

A process model can have several (connected) sub-models and or sub-procedures (Binner, 2004; Figl, et al., 2013; Prilla, 2010) and can be industry-specific (e. g. Supply Chain Operations Reference Model SCOR-Model) or function-specific (e. g. ICT-specific: IT Infrastructure Library ITIL, Control Objectives for Information and Related Technology COBIT) (Zeibig, 2011). Process models can be developed in different granularity, on different levels, for different hierarchies and/or various perspectives, depending on the specific goal (Scheer, 2002). In terms of levels, process models can be on a generic or on an execution oriented process level, while the latter again can be differentiated between the main process level, the business process level, the activities level or the work step level (Becker, et al., 2012). In terms of hierarchies, process models can be for top management, process owners, operational executors or any other hierarchical level (EABPM, 2014). Process models can be developed bottom-up and/or top-down on the basis of document analyses, interviews, workshops, observations, surveys, route cards, virtual conferences or by a mixture of those methods applied with experts, managers, operational employees and/or other process stakeholders (EABPM, 2014; Keller & Teufel, 1997; Prilla, 2010).

Process model languages are supposed to support the communication about processes between (non-technical) stakeholders and can be made out of (standardized) symbols which can show flows, events, decisions, junctions and relationships between the symbols and the outer context (EABPM, 2014; Fettke & Loos, 2012). Examples of specific process modelling languages are the Business Process Modelling Notation (BPMN), Flow chars, Event-driven Process Chain (EPC), Unified Modelling Language (UML), Integrated Definition Language (IDEF), Value Stream Mapping, Role Activity Diagram (RAD), Value Chain, Supplier/Input/Process/Output/Customer (SIPOC) systems diagrams, Yet Another Workflow Language (YAWL), XML Process Definition Language (XPDL), Petri nets, Process Interchange Format (PIF), Semantic Object Model (SOM) (Bork & Sinz, n.d.; DIN, 2000; EABPM, 2014; Letsholo, et al., 2014; Marx Gomez, n.d.; Prilla, 2010; Wahler, 2009) (cf. subsection 2.6.3).

2.6.2.5 Information Models

Information models can be seen as classical artefacts within Information Systems Research and/or as mediators between business and information technology, focusing on the understanding of information structures and analysis, design, implementation and deployment of information systems (Delfmann, 2006; Fettke & Loos, 2003b; Fettke & Loos, 2003a; Fettke & Loos, 2004b; Thomas, 2006a; Schütte, 1998; vom Brocke, 2003). According to Delfmann (2006) and Schwegmann (1999), information models are a necessary tool for designing effective and efficient information and application systems. Information models can be developed based on different methods, e. g. observations, meta analysis of publications, Delphi method, statistics (Haux, et al., 1998) and different notations, informal, semi-formal or natural languages (Fettke & Loos, 2003c). The goals of information models can be manifold, e. g. the

- documentation of the current or a future setup of information system(s)
- decision support for the acquisition of software (licences)
- enabling of the engineering of organisation and application systems
- support to design efficient data handling and communication

(Becker, et al., 2002; Delfmann, 2006; Haas & Röhrig, 2009; Schütte, 1998)

2.6.2.6 Data Models

Data models

- are constructs of data systems which are themselves part of information systems.
- deal with logic aspects of databases and concepts, methods, techniques and tools for the database design
- describe data objects and their relationships
- can deal with the physical data storage (internal scheme) or the user perspective (external scheme)
- can be semantic or conceptual
- can have different perspectives: process-orientation, object-orientation

(Haux, et al., 1998; Maier, 1996; Speck, 2001)

In Business and Management (Research) and Information Systems (Research) data models are applied

- as a basis for the development of applications, the design of databases, the selection and/or application of standard software, the integration and management of information systems, standardization or the usage of application systems in the departments
- for a complete and redundancy-free documentation of information, messages and data in organisations as well as the relationships between object types within the information system and the interlinks
- for staff training and augmenting staff acceptance
- for the automatic generation of database structures
- to reduce maintenance efforts
- to ensure stability, implementability, data integrity, data security, data quality, data consistency, data currency and data protection
- for the formalization of the use of data
- for the definition of a data management, information systems and ICT infrastructure strategy
- for the requirements description and the management of software/data storage/data processing/information exchange
- for the support of communication between departments
- to assure the right data at the right time for the right purpose/user
- to increase productivity of application systems and efficiency in accessing data
- for the complex linking of data and data integration across all areas
- to prevent data chaos

(Becker & Pfeiffer, 2007; Hars, 1994; Haux, et al., 1998; Haux, et al., 2010; Maier, 1996; Speck, 2001).

The following notations are suggested for data modelling: Entity Relationship Modelling Notation (ERMN) (e. g. Chen, ARIS, CIMOSA), Unified Modelling Language (UML), Petri nets, Integrated Definition Language (IDEF), Information Engineering, Object Role Modelling (ORM) (EABPM, 2014; Hahne, 2013; Hars, 1994; Haux, et al., 1998; Haux, et al., 2010; Letsholo, et al., 2014; Maier, 1996; Speck, 2001) (cf. subsection 2.6.3).

2.6.2.7 Enterprise Models

Enterprise models are defined as abstractions of enterprises, ideally combining several aspects like functional, technical, organisational, data and process models, showing the operations, financial and information processes including sequential and logical aspects in a holistic way, using a modelling language appropriate for the respective context (Frank, 2014; Frank, n.d.b; Haux, et al., 1998; Haux, et al., 2010; Kruse, 1996; Noran, 2007). A well-known example of an enterprise modelling framework is the Zachman framework for information systems architectures (Zachmann, 1987). Enterprise models have the goal to

- support communication and common understanding
- structure, disseminate, promote and reuse existing knowledge
- reach optimally aligned software application
- support the operation and management of businesses
- enable the configuration, implementation and management of the ICT infrastructure
- analyse the business, to detect weaknesses and to reveal potential for optimization

(Frank, 2014; Noran, 2007; Noran, 2004).

2.6.3 Modelling Languages / Notations

To be able to create the desired models in an appropriate manner, different modelling languages or notations can be used. A modelling language or notation defines the

- syntax (how something is symbolized/represented) and
- semantics (rules about how to apply/interpret the symbols/representation and how they can be put in relation to each other)

of a model with the means of text or graphical elements (Becker, et al., 2012; DIN, 2000; EABPM, 2014; Fettke & Loos, 2004c; Prilla, 2010; Volz, 2011). Symbols and rules can be set up informally or can be officially standardized. The advantage of a standardized notation is, according to the European Association of Business Process Management EABPM (2014), DIN (2000) and vom Brocke (2003), the common understanding and thus an easier communication and the facilitated design, analysis and measuring as well as reuse and sharing thanks to consistency. As the modelling language sets the framework of the expressiveness of a model, it is important to choose the appropriate modelling language depending on the context and needs (Hars, 1994; Speck, 2001; Wand, et al., 1995).

Modelling languages can be classified either by the combination of the formality of the modelling and by the representation according to Bartsch (2010) as illustrated in Table 4 or, according to Hars (1994), by distinguishing between the logic, the graph-based or the procedural approach (which however do not exclude each other):

- the logic approach is specifically suited to a strong need for formalization
- the procedural approach mainly offers the possibility of a high degree of expressiveness
- the graph-based approach is object-centred, offers a high degree of comprehensibility, decomposability and changeability

Table 4: Classification of modelling notations according to Bartsch (2010, p. 85-86)

		Illustration	
		text-based	**graph-based**
Modelling	**informal**	e. g. natural language	e. g. drawing
	semi-formal	e. g. XML, XPDL, WS-BPEL	e. g. EPC, UML, BPMN, ERMN
	formal	e. g. Z^{00}	e. g. petri nets

In the context of Business and Management (Research) and Information Systems (Research), models are often graph-based models, because they are generally easily understandable and interpretable and thus suited as a basis for a common understanding between stakeholders of different disciplines (Fettke & Loos, 2003c; Frank, et al., 2014; Grochla, 1974; Hars, 1994; Prilla, 2010; Strecker & Fettke, 2014).

Table 5 gives an overview of frequently used modelling language /notations within Business and Management (Research) and Information Systems (Research).

Table 5: Graph-based modelling languages/notations

Name of modelling language	Description	Sources
Business Process Modelling Notation (BPMN)	Symbol-based, standardized notation to illustrate (business/working) processes/sequences	(Allweyer, 2010; BPM Offensive Berlin, 2011; Freund & Rücker, 2017)
Entity Relationship Diagram / (modified) Chen notation (ERD or ERMN)	Notation to show relationship between entities, mainly using - rectangular boxes for entities - diamond-shaped boxes for relationships - lines (single for optional and double for mandatory relationships) - cardinality indications (one-to-one, one-to-many, many-to-many)	(Academic dictionaries and encyclopedias, n.d.; Chen, 1976; Chen, 1981; Chen, 1991; Chen, 2002; Purchase, et al., 2004; Song, et al., 1995)
Event-driven process chains (EPC)	Notation for the illustration of temporal and logical dependencies of business process activities mainly using - events - function - connectors (logical AND ∧, logical exclusive OR XOR and logical OR ∨); are reduced illustrations of petri-nets	(DIN, 2000; EABPM, 2014; Mendling, et al., 2007; Recker, et al., 2007; Rosemann, 1996; Wahler, 2009)
Flow chart / Workflow	Very simple, graph-based, non-standardized possibility to draft processes	(EABPM, 2014)
Unified Modelling Language (UML)	Notation for structuring (software and/or information) systems, particularly for defining requirements with the help of different standardized diagrams (activity, collaboration, sequence, status diagrams), mainly using control and data-flow edges to illustrate actions, control nodes like decision, merge, fork or join for parallel or alternative splits and joins of process flows	(Brücher & Endl, 2002; DIN, 2000; EABPM, 2014; Letsholo, et al., 2014; vom Brocke, 2003; Wahler, 2009)
System diagram /System flow charts	Strategic view on relationships within service provision processes by the means of feedback loops and possibilities of simulations	(EABPM, 2014)

In this thesis, for the metamodel the Modified Entity Relationship Model notation (Modified Chen-Notation) based on Academic dictionaries and encyclopedias (n.d.), Chen (1976), Chen (1981), Chen (1991) and Chen (2002) and for the procedure reference model, the Business Process Management Notation (BPMN 2.0, according to Allweyer (2010), BPM Offensive Berlin (2011) and Freund und Rücker (2017) were chosen (justification cf. subsection 3.2.6.2).

2.6.4 Concluding Remarks about Conceptual Models in the Healthcare Context

For the non-medical context in hospitals, Business and Management (Research) and Information Systems (Research) are essential which is why the aspects described above also apply for models in hospitals (Juhrisch, et al., n.d.; Gadatsch, 2013; Haux, et al., 2010; Winter, et al., 2005). In the medical context, variations of clinical processes, clinical pathways and clinical practice guidelines have been applied with the goal to improve medical care, e. g. Bögel et al. (2011), Burwitz et al. (2013), Juhrisch et al. (Juhrisch, et al., n.d.), Richter (2008), Schlieter (2012), Schuld et al. (2011), Thun (2009b), which is however not the focus of this thesis (cf. section 1.5).

The subject of the act of modelling and the evaluation of models is discussed in subsection 3.2.6.

In this thesis, the research subject is a procedure reference model with an inherent metamodel, constructed by graph-based, standardized modelling notations, explicitly following Frank (2007a, pp. 119-120) by "neglecting technical aspects that are related to the implementation of corresponding software systems."

3 Research Methodology

A research methodology is an appropriate combination of processes, methods and tools to inquire into specific situations and to obtain answers in a research domain (Easterby-Smith, et al., 2012; Hevner & Chatterjee, 2010; Nunamaker, et al., 1991; Vaishnavi & Kuechler, 2008). This chapter will explain the research methodology of this thesis with the scientific position / philosophical grounding, the methodological position, the derivation of the research design and the applied quality criteria framework considerations as illustrated in Figure 16.

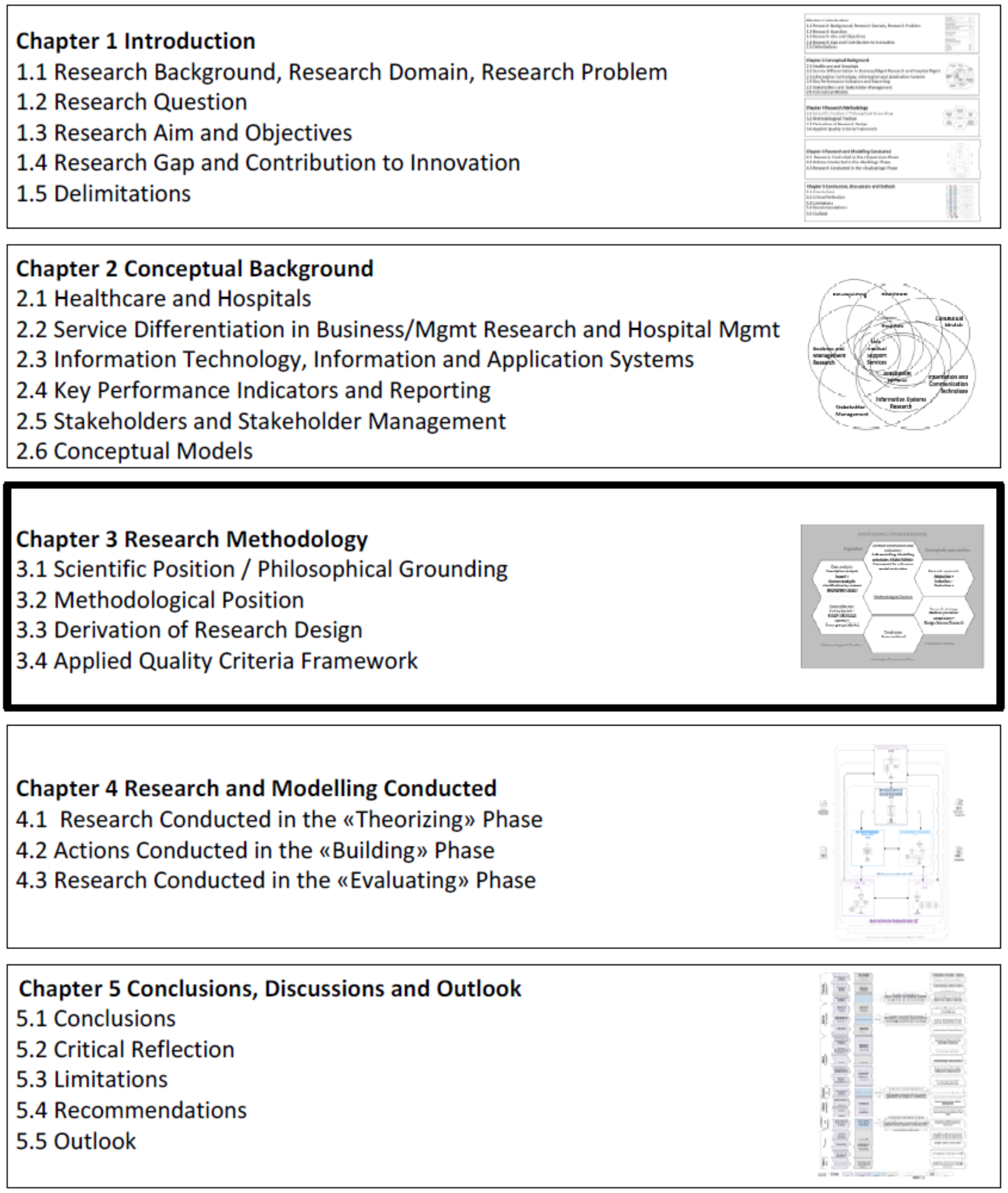

Figure 16: Context of chapter 3 within the whole thesis

3.1 Scientific Position / Philosophical Grounding

In this section, the scientific position and philosophical grounding including the basic belief, ontology, epistemology, concept of truth and axiology are explained.

3.1.1 Basic Belief

Research is done with scientific positions or philosophical assumptions. By not aligning itself with any philosophical stance, one of the most unfundamentalist scientific positions is pragmatism (Bogusz, 2013; Creswell, 2014; Greene & Hall, 2010; Wilson, 2014). Pragmatism offers a philosophical and methodological middle position for applied research, allowing or even asking for mixed methods application, combining methods in such a way that they achieve their purpose (Clark & Creshwell, 2008; Creswell, 2014; Greene, 2007; Greene & Hall, 2010; Maxcy, 2003; Morgan, 2007; Teddlie & Tashakkori, 2003; Wilson, 2014). According to Greene (2007, p. 83), pragmatism puts action over philosophizing and views knowledge "as being both constructed and based on the reality of the world we experience and live in." In pragmatism, truth is seen to be tentative and changeable over time, as something that has a situational and current relevance and a utility (Clark & Creshwell, 2008; Creswell, 2014; Greene, 2007; James, 2006). For pragmatic researchers, the focus is therefore more on the research problem and research question than on the methods; in pragmatism, methods, techniques and procedures can be chosen freely, however in an appropriate combination and a useful manner (Creswell, 2014; Hevner, 2007b; Wilson, 2014).

The underpinning basic belief of this thesis is pragmatism based on Bogusz (2013), Clark and Creshwell (2008), Creswell (2014), Greene (2007), Greene and Hall (2010), Hevner (2007b), James (2006), Maxcy (2003), Morgan (2007), Teddlie and Tashakkori (2003) and Wilson (2014).

3.1.2 Ontology

Ontology is concerned with the question of what is real and what is not, so the researcher's assumption of reality or the real world (Easterby-Smith, et al., 2012; Saunders, et al., 2016). According to Saunders et al. (2009), Vaishnavi and Kuechler (2008) and Wilson (2014), the philosophy of pragmatism asks for a multiple (objective and subjective) view, socio-technically enabled, dependent on the context-specific answers needed. Vaishnavi and Kuechler (2008) add, that in Design Science Research, ontological viewpoints might change throughout the development.

In this thesis, an ontologically open position with a multiple view according to Saunders et al. (2009), Vaishnavi and Kuechler (2008) and Wilson (2014) is taken.

3.1.3 Epistemology

Epistemology deals with the question of what the nature of acceptable knowledge is, what it depends on and how it is acquired (Easterby-Smith, et al., 2012; Saunders, et al., 2016). Generating a conceptual model includes different epistemological positions: according to Becker and Pfeiffer (2007), there are antirealistic epistemological aspects in the social process of gathering data amongst stakeholders and realistic aspects when transferring the information in alternative modelled forms. Purao (2002) acknowledges both reflective and hermeneutic aspects in the modelling process. Vaishnavi and Kuechler (2008, p. 17) circumscribe the epistemology of Design as "Knowing through making: objectively constrained construction within a context[;] Iterative circumscription reveals meaning", pointing out – as in the ontological context – that the epistemological viewpoints in the Design Science Research approach can shift during the process of research.

As the goal of this thesis is to develop a conceptual model, it follows the epistemological pluralism, suggested in Design Science Research literature (Becker & Pfeiffer, 2007; Purao, 2002; Vaishnavi & Kuechler, 2008).

3.1.4 Concept of Truth

The concept of truth is concerned with the question what true cognition is (Habermas, 2008).

Following the pragmatic philosophy, the consensus theory according to Habermas (2008) is followed, according to which a statement can only be true for a set of individuals, if it is rationally accepted as true by the group.

3.1.5 Axiology

Axiology deals with the question of what the value and the role of the researcher's value perception in the research is (Saunders, et al., 2009; Wilson, 2014). Vaishnavi and Kuechler (2008, p. 18) point out that the design science researcher "values creative manipulation and control of the environment in addition to (if not over) more traditional research values such as the pursuit of truth or understanding" which leads to a higher need for tolerance of ambiguity firstly because a designed artefact might not be commonly understood and still be declared a success by a certain community and secondly because the perception – as much as the ontological one – might change throughout the research process.

Following the philosophical grounding of pragmatism, in this thesis an axiologically open position according to Vaishnavi and Kuechler (2008) is adopted.

3.2 Methodological Position

In the following subsections, the methodological position of the thesis is explained along the framework of Wilson (2014, p. 117), including research approach, research strategy, research time frame, methods of data collection and data analysis and, due to the context, adding the aspect of artefact construction. The context is illustrated in Figure 17.

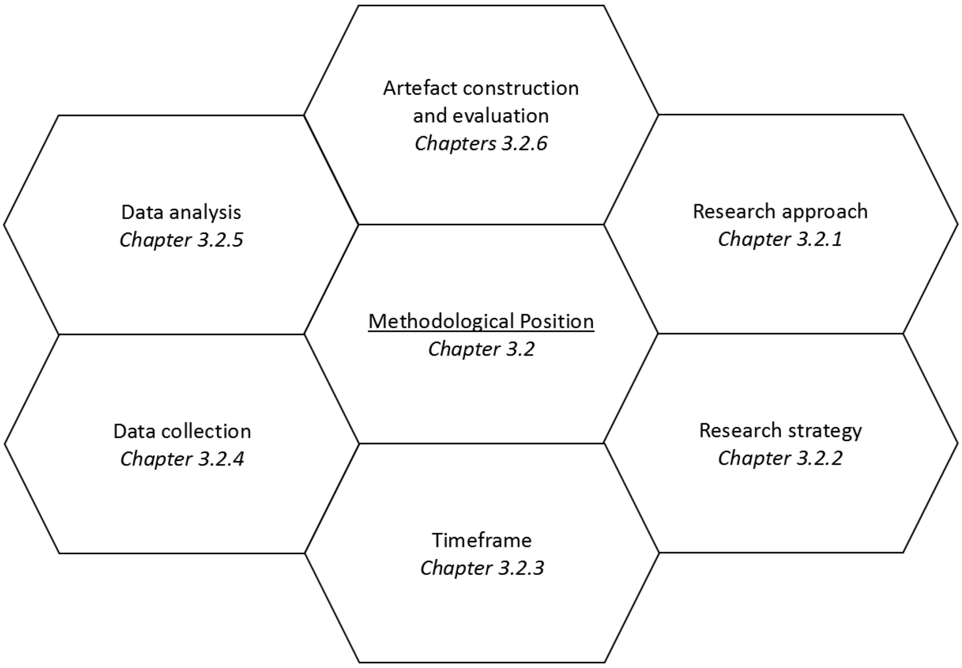

Figure 17: Illustration of methodological position based on Wilson (2014, p. 117)

3.2.1 Research Approaches

Based on Dresch et al. (2015), Mayer (2013) and Saunders et al. (2009), the following approaches can be distinguished:

- induction: asking the question "What is?", starting with observations and generating theory via hypotheses moving from the general to the specific
- deduction: starting with theory and leading via hypotheses to observations, moving from the specific to the general by asking the question "What should be?"
- abduction: asking the question "What could be?" and interacting between the specific and the general (Bryman & Bell, 2015; Habermas, 2008; Richter, 1995).

Figure 18 illustrates the three different research approaches induction, abduction and deduction while Table 6 specifies the differences between the three approaches.

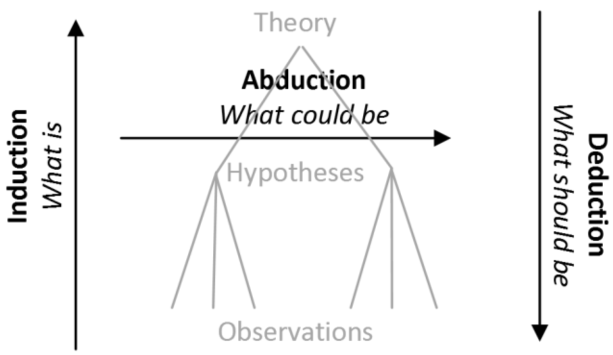

Figure 18: Abduction – Deduction – Induction based on Dresch et al. (2015) and Mayer (2013)

Table 6: The differences between Deduction, Induction and Abduction based on Saunders et al. (2009, p. 145) and Morgan (2007, p. 71)

	Deduction	**Induction**	**Abduction**
Logic of inference	When the premises are true, the conclusion must also be true	Known premises are used to generate untested conclusions	Known premises are used to generate testable conclusions
Generalising	From the general to the specific	From the specific to the general	From the interactions between the specific and the general
Use of data collection	To evaluate propositions or hypotheses related to an existing theory	To explore a phenomenon, identify themes and patterns and create a conceptual framework	To explore a phenomenon, identify themes and patterns, locate these in a conceptual framework and test this through subsequent data collection and so forth
Theory	Falsification or verification	Theory generation and building	Theory generation or modification; incorporating existing theory where appropriate, to build new theory or modify existing theory
Relationship to research process	Objectivity	Subjectivity	Intersubjectivity
Inference from data	Generality	Context	Transferability

In this thesis, abductive, deductive and inductive approaches according to Bryman and Bell (2015), Dresch et al. (2015), Habermas (2008), Mayer (2013), Morgan (2007), Richter (1995) and Saunders et al. (2009) were applied in different stages as shown in Figure 19.

3.2.2 Research Strategy

Defining the research strategy depends on the scientific position (cf. subsection 3.1.3).

In this thesis, following an epistemological pluralism, a method pluralistic research approach applying multiple methods according to Dresch et al. (2015a), Frank (2006), Gregor and Jones (2007), Hevner and Chatterjee (2010), Huysmans and Verelst (2012), Kuechler et al. (2008), Niehaves (n.d.), Österle et al. (2010), Picot (2010) was chosen.

Based on this thesis' context, this subsection summarises the research strategies of empiricism within Business and Management Research as well as those in Design Science Research and discusses different possibilities of mixing and combining strategies.

3.2.2.1 Empiricism

Empiricism is defined as knowledge of people based on experiences through observation and experiments and thus a posteriori (Duignan, et al., n.d.; Easterby-Smith, et al., 2012; Merriam-Webster, n.d.). In Business and Management Research as one of the disciplines of social research, qualitative and quantitative empirical research methods are commonly applied for both data gathering and data analysis. Table 7 shows the ideal-typical comparison between the qualitative and quantitative paradigm based on Grbich (2007) and Lamnek (1995).

Table 7: Ideal-typical comparison between the qualitative and quantitative paradigm (based on Grbich, 2007 and Lamnek, 1995)

Basic/quantitative research	**Applied/qualitative research**
deductive theory testing	**inductive** theory developing
explaining differences	**understanding** similarities
objectivity (distance, neutrality)	**subjectivity** (identification)
closed/standardizes methods	**open**/non-standardized methods
researcher control process/pre-determination of researcher	power with **participants** as subject experts / relevance system of those concerned
survey and experimental research, **pre-specified** hypotheses dictate questions and approach	interviews, exploratory and **open-ended** questions, data in narrative form
static/measurable reality	**dynamic-procedural**/reality as shifting feast
particularistic/analytical/abstracting	**holistic**/concretizing
random sampling	**theoretical sampling**
high measuring level, reductive data analysis	**low measuring level, explicative data analysis**
conclusion logically drawn from certain premises (mostly rule based) viewed as proven, valid or true; linearity (**cause - effect**)	using a research question and **moving from instances** gained in the data collection to some form of conclusion, often via comparison with existing concepts or theory
precision through statistical approaches	**interpretative analysis** through thematic approaches
identification of numbers and clarification of **relationships between variables**	development of **explanatory concepts and models**, dealing with meanings, descriptions, values and characteristics of people and things
generalisation and predictability sought	widespread generalisation avoided, **typification**
researcher as independent observer and diagnostician of social relations	**researcher as factual and virtual participant**, advocate, scout
theory of **convergence and correspondence about truth**	theory of **consensus and discourse**

In this thesis, following a method pluralistic research approach (cf. subsection 3.2.2), both qualitative and quantitative empirical research strategies are applied, however with a strong focus on the qualitative approach.

3.2.2.2 Design Science Research (DSR) Methods

The background of Design Science Research and its application throughout this thesis are discussed in subsection 2.3.5.2.

In terms of methods, various possible empirical and non-empirical building and evaluation techniques are mentioned within DSR literature as can be seen in Table 8.

Table 8: Examples of building and evaluation methods/techniques proposed within design-oriented research

	Methods proposed	Sources
Empirical building and evaluation techniques	**Action Research**	(Baskerville, et al., 2009; Bilandzic & Venable, 2011; Braun, et al., 2004; Dresch, et al., 2015; Frank, 1997; Galliers, 1992; Järvinen, 2005; Nunamaker, et al., 1991; Österle, et al., 2010; Sein, et al., 2011; Siau & Rossi, 1998; Wieringa & Morah, 2012; Wilde & Hess, 2006)
	Case studies (Classic / Collective / Common / Exploratory / Explanatory / Instrumental / Intrinsic / Multiple / Observational case studies)	(Braun, et al., 2004; Dresch, et al., 2015; Galliers, 1992; Hevner, et al., 2004; Huysmans & Verelst, 2012; Roworth-Stokes, 2006; Siau & Rossi, 1998; Teegavarapu & Summers, 2008; Wieringa, 2014; Wilde & Hess, 2007)
	Content / Document Analysis	(Braun, et al., 2004; Lehner, 2001; Wilde & Hess, 2007)
	Ethnography	(Braun, et al., 2004; Hevner & Chatterjee, 2010; Wilde & Hess, 2007)
	Experiments (Controlled / Field / Laboratory / Simulation / Single case mechanism / Statistical difference-making Experiments)	(Braun, et al., 2004; Frank, 1997; Galliers, 1992; Hevner, et al., 2004; Huysmans & Verelst, 2012; Lehner, 2001; Nunamaker, et al., 1991; Österle, et al., 2010; Siau & Rossi, 1998; Wieringa, 2014; Wilde & Hess, 2006)
	Focus Groups	(Dresch, et al., 2015; Gibson & Arnott, 2007; Hevner & Chatterjee, 2010; Huysmans & Verelst, 2012)
	Game Role Playing / Operational Gaming	(Frank, 1997; Galliers, 1992)
	Grounded Theory	(Braun, et al., 2004; Wieringa, 2014; Wilde & Hess, 2007)
	Observations	(Dresch, et al., 2015; Gregor & Hevner, 2013; Hevner & Chatterjee, 2010; Hevner, et al., 2004; Lehner, 2001; Siau & Rossi, 1998)
	Surveys / Interviews (Descriptive / Explanatory / Exploratory Survey)	(Braun, et al., 2004; Dresch, et al., 2015; Frank, 1997; Galliers, 1992; Lehner, 2001; Nunamaker, et al., 1991; Österle, et al., 2010; Siau & Rossi, 1998; Wilde & Hess, 2006)
Non-empirical building techniques	**Method Engineering**	(Gericke, 2009; Nunamaker, et al., 1991; Österle, et al., 2010; Ralyté, et al., 2003; Siau & Rossi, 1998; vom Brocke, 2003; Winter & Schelp, 2006)
	Creativity Techniques	(Braun, et al., 2004; Wilde & Hess, 2006)
	Forecasting	(Braun, et al., 2004; Galliers, 1992; Wilde & Hess, 2006)
	Modelling (Business Information (Systems) / Conceptual / Enterprise / Functional / Hard / Meta- / Multi-dimensional / Multi-perspective / Object (oriented) / Organisational / Power / Process / Reference / Role / Soft / Term Modelling)	(Becker, et al., 2012; Braun, et al., 2004; Checkland, 1999b; Chen, 1976; DIN, 1996; Delfmann, 2006; Dresch, et al., 2015; Fettke, 2009; Frank, 2014; Gemino & Wand, 2003) (Gericke, 2009; Hahne, 2013; Hars, 1994; Haux, et al., 1998; Juhrisch, et al., n.d.; Keller & Teufel, 1997; Kruse & Scheer, 1992; Lehner, 2001; Mendling, et al., 2007; Müller & Johner, 2009) (Noran, 2007; Nunamaker, et al., 1991; Österle, et al., 2010; Perros, 2009; Pidd, 2003; Prilla, 2010; Rosemann, 1996; Schlagheck, 2000; Scheer & Nüttgens, 2000; Schermann, et al., 2009) (Schütte, 1998; Siau & Rossi, 1998; Speck, 2001; Thomas, 2006b; vom Brocke, 2003; Wilde & Hess, 2006)
	Prototyping	(Anderson, et al., 2012; Baskerville, et al., 2009; Braun, et al., 2004; Dresch, et al., 2015; Hevner & Chatterjee, 2010; Nunamaker, et al., 1991; Österle, et al., 2010; Wieringa, 2014)

Continued

Table 8: Examples of building and evaluation methods/techniques proposed within design-oriented research - Continued

<table>
<tr><th></th><th>Methods proposed</th><th>Sources</th></tr>
<tr><td rowspan="5">Non-empirical (evaluation) techniques</td><td>Analysis
(Architecture / Dynamic / Optimisation / Paradigmatic / Static Analysis)</td><td>(Hevner, et al., 2004; Österle, et al., 2010; Siau & Rossi, 1998)</td></tr>
<tr><td>Descriptive Evaluation
(Informed Argument, Scenarios)</td><td>(Hevner, et al., 2004)</td></tr>
<tr><td>Feature Comparison; Metrics Approach; Contingency Identification, Ontological Evaluation: Approaches Based on Cognitive Psychology</td><td>(Siau & Rossi, 1998)</td></tr>
<tr><td>Statistics
(Cluster Analysis / Discriminate Analysis / Factor Analysis / Multiple Regression / Multi-variate Techniques / Non-parametric Methods / Uni-variate Methods)</td><td>(Pervan & Klass, 1992)</td></tr>
<tr><td>Testing
(Functional (Black Box) / Structural (White Box) Testing)</td><td>(Hevner, et al., 2004; Wilde & Hess, 2006)</td></tr>
</table>

Different cycles and frameworks illustrating the iterative procedure (phases, steps) and corresponding methods and outputs for conducting DSR have been developed as a basis for the artefact research and development process (Baskerville, et al., 2009; Dresch, et al., 2015; Eekels & Roozenburg, 1991; Fettke & Loos, 2012; Gerber, et al., 2018; Gregor & Jones, 2007; Hevner & March, 2003; Hevner & Chatterjee, 2010; Kuechler, et al., 2008; Manson, 2006; March & Smith, 1995; Meyer & Kenneally, 2012; Nunamaker, et al., 1991; Ostrowski, 2012; Ostrowski, et al., 2012; Wieringa, 2014).

For this thesis, the "Design Science Research Cycle for Business and Management Research" by Gerber et al. (2018) illustrated in Figure 19 was chosen as a conceptual basis. The research design and the logic of the scientific discourse will therefore be set up based on the three phases

- Theorising
- Building
- Evaluating

including the potential of iterativeness of the framework (cf. section 3.3 and chapter 4 et seq.).

Reflecting is done in chapter 5 and Dissemination will be possible after the publication of the thesis (cf. subsection 5.1.2.2)

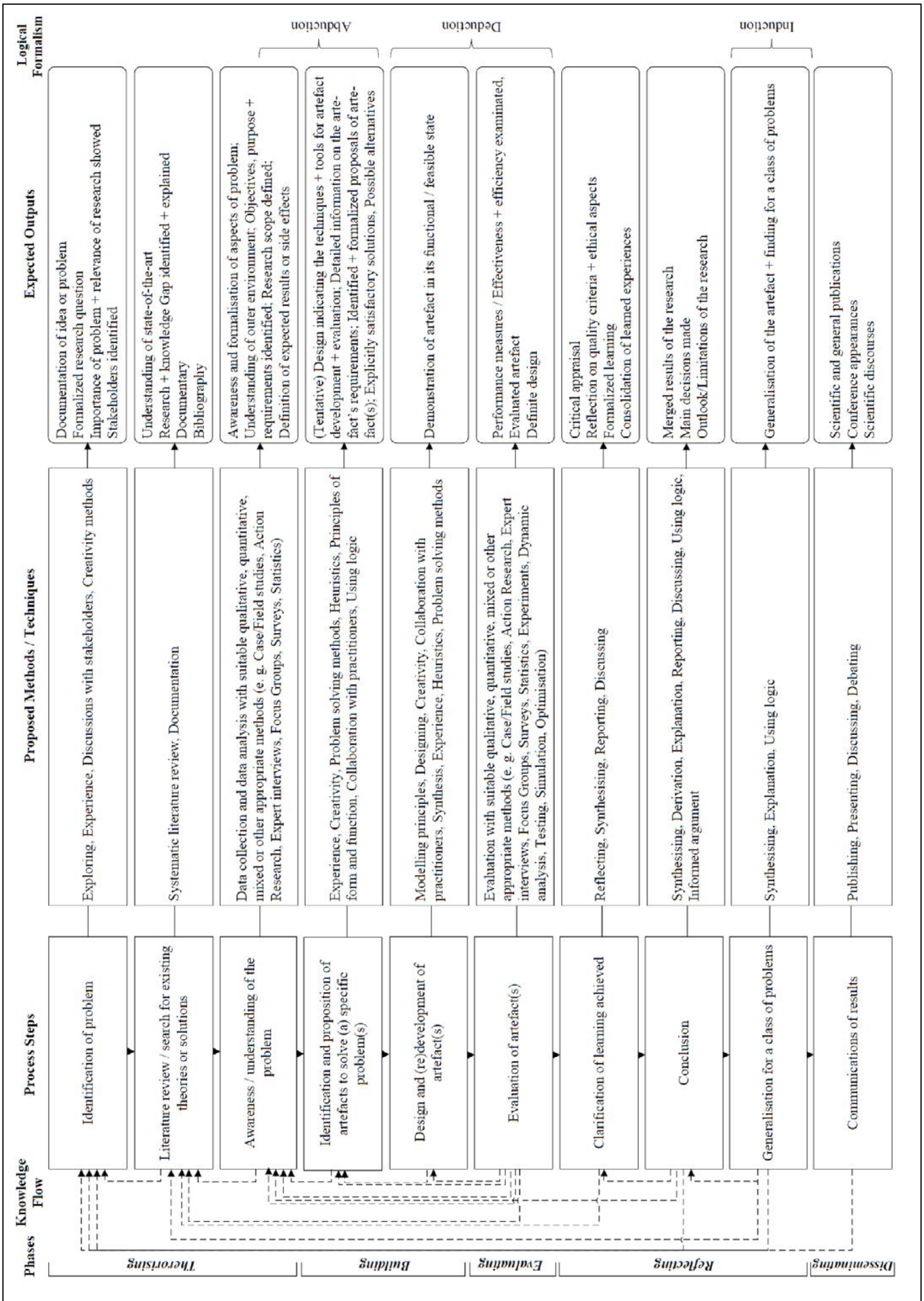

Figure 19: Design Science Research Cycle for Business and Management Research (Gerber, et al., 2018, p. 7)

3.2.2.3 Combining Methods / Applying Method Pluralism

Representatives of social empirical and Business and Management Research have been suggesting the "mixed methods" approach combining qualitative (open-ended) and quantitative (close-ended) data and thus the corresponding research methods throughout a research project (collection, analysis, interpretation, presentation) (Bryman & Bell, 2015; Creswell, 2014; Flick, 2016; Kelle & Erzberger, 2000; Kuckartz, 2014; Morse & Niehaus, 2009; Tashakkori & Teddlie, 2003; Teddlie & Tashakkori, 2010). A general understanding among the above-mentioned authors is that

- every method has advantages and disadvantages and that the choice of the mix should take them into consideration,
- the application of the methods has to be systematic and rigorous and has to respect the corresponding principles and
- there is a point of interaction or interference.

The understanding on how and when to mix the methods and how to call the combinations however differs. Creswell (2014) and Creswell and Plano Clark (2018) differentiate on a basic-level between the

- convergent design (collection and analysis of both quantitative and qualitative data, comparing the results in the end as a way of validation),
- explanatory sequential design (investigation with quantitative methods and explanation with qualitative methods) and
- explanatory sequential design (exploration with qualitative methods as a basis for a quantitative phase)

adding the possibilities of the following advanced combinations:

- intervention design (when adding two or more of the above-mentioned basic designs in a larger framework)
- social justice or transformative design (adding a social justice framework to a combination of the above-mentioned basic designs) and
- multistage evaluation designs (combining different combinations throughout a longitudinal study).

The combination can, according to Creswell (2014) evolve throughout a project and variations of the suggested designs are possible. Morse and Niehaus (2009) distinguish between

- the core, complete component and
- a supplementary, incomplete component.

In a simultaneously mixed design, the complete and the supplementary component are conducted simultaneously while in the sequential mixed design the supplementary component is conducted after the core component. In an emergent design, during or after the core component, another project is added. For Morse and Niehaus (2009), core and supplementary components can both be either qualitative and/or quantitative and can be conducted in the analysis point of interface or the result point of interface. For Flick (2016), the prioritization of one paradigm is not necessary, however he differentiates between the

- combination of qualitative and quantitative data,
- transfer of qualitative data into quantitative data,
- transfer of quantitative data into qualitative data,
- combination of qualitative and quantitative methods and
- combination of qualitative and quantitative results.

Patton (1990, pp. 191-192) enlarges the mixed forms by mentioning different combinations:

- "Experimental Design, Qualitative Data, and Content Analysis" […]
- "Experimental Design, Qualitative Data, and Statistical Analysis" […]
- "Naturalistic Inquiry, Qualitative Data, Statistical Analysis" […]

- “Naturalistic Inquiry, Quantitative Data, Statistical Analysis”

In literature, there is no unanimous notation about how to describe mixed methods designs.
In this thesis, the mixed methods notation based on Creswell and Clark (2018, pp. 62-63) and listed in Table 9 is used.

Table 9: Mixed methods notation presented by Creswell and Clark (2018, pp. 62-63)

Notation	Explanation
Quan/Qual	Quantitative/Qualitative approaches for data collection, analysis and interpretation are applied
QUAN/QUAL	Upper cases indicate the emphasised/prioritised approach in the design
quan/qual	Lower cases indicate the lesser emphasised/prioritised approach in the design
QUAN + QUAL / QUAL + QUAN	The approaches occur concurrently with the same priority
QUAN + qual / quan + QUAL / QUAL + quant / qual + QUAN	The approaches occur concurrently with different prioritisation
QUAN -> QUAL / QUAL -> QUAN	The approaches occur in a sequence with the same priority
QUAN -> qual / QUAL -> quan / quan -> QUAL / qual -> QUAN	The approaches occur in a sequence with different prioritisation

Within the Design Science Research principles (cf. subsection 3.2.2.2), methodological pluralism and multi-method research include even more dimensions, appropriately combining various (not only empirical) methods within a project approach (Dresch, et al., 2015; Hevner & Chatterjee, 2010; Huysmans & Verelst, 2012; Niehaves, n.d.; Österle & Otto, 2010; Österle, et al., 2010; Picot, 2010). Huysmans and Verelst (2012) expand the idea of “mixed methods” by combining Design Science Research and empiricism in different variations between pacing and point of interface as illustrated in Table 10.

Table 10: Mixed methods combining Design Science Research principles and empiricism based on Huysmans & Verelst, 2012, pp.115-117

Research Design	**Pacing**	**Point of interface**	**Notation**
Concurrent exploratory	Design and empirical component concurrently executed	Problem identification phase of design research component	DESIGN + empirical
Concurrent creative		Solution design phase of design research component	DESIGN + empirical
Concurrent evaluative		Evaluation phase of design research component	DESIGN + empirical
Sequential exploratory	Empirical component precedes design component	Interpretation phase of empirical research component	empirical -> DESIGN
Sequential explanatory	Design component precedes empirical component	Communication phase of design research component	DESIGN -> empirical

The combination of DSR and mixed methods principles are implicitly described by the “intersecting mixed methods with another methodology” approach within the idea of “intersecting core mixed methods designs with other research approaches or frameworks” presented by Creswell and Plano Clark (2018, pp. 102-103) and by the explanation of the “iterative, cyclical approach to research” as well as the “reliance on visual representations […] and a common notational system” by Teddlie and Tashakkori (2010, pp. 11-15).

Applying a multi-method approach is suggested for different reasons: Bryman and Bell (2015), Creswell (2014), Niehaves (n.d.) and Kuckartz (2014) describe the advantage of enabling the inclusion of different perspectives on a specific phenomenon when applying different methods and thus the potential of a better understanding. Nunamaker et al. (1991), Grbich (2007) and Flick (2016) take the view that throughout the different iterations, different questions, necessities and challenges arise and therefore trigger the need for correspondingly adequate, varying methods. Bryman and Bell (2015), Kuckartz (2014) and Teddlie and Tashakkori (2010) point out that the potential of generalizability, contextualisation, differentiation and understandability of results can be increased when applying mixed methods. Österle and Otto (2010b) explain that, particularly in consortial projects where academic and business partners cooperate, the different expectations and perspectives can predominantly be satisfied, if the corresponding (multiple) methods are applied. Bryman and Bell (2015) and Picot (2010) add the fact that particularly when trying to solve problems in an innovative manner, a (potentially new and thus also innovative) combination of different methods can be supportive.

However, mixing methods of any kind, Becker and Pfeiffer (2007), Biesta and Burbules (2003), Creswell (2014), Flick (2016), Grbich (2007), Kuckartz (2014), Morse and Niehaus (2009) and Teddlie and Tashakkori (2010) point out that not all combinations are suitable for every project or context. They therefore recommend not only a clear and systematic definition, but also an explicit reflection and discussion of the chosen method combination(s) and the respect for the corresponding methodological assumptions so that the application of a method pluralism does not lead to premature and shallow designs and/or results.

Pragmatism (cf. section 3.1) is seen as a well suited world view to be applied in a mixed methods research design (Clark & Creshwell, 2008; Creswell & Plano Clark, 2018; Johnson & Onwuegbuzie, 2004; Maxcy, 2003; Teddlie & Tashakkori, 2003).

In this thesis, based on the scientific position (cf. section 3.1), a method pluralistic research approach was chosen, combining empiricism and Design Science Research approaches according to Huysmans and Verelst (2012).

In the “Theorising” phase, the combination of methods has a sequential exploratory character starting with an empirical component followed by a design component. The empirical component has an explanatory sequential character according to Creswell (2014) and Creswell and Plano Clark (2018), representing the case selection variant based on Creswell and Plano Clark (2018, p 82), investigating with quantitative methods and explaining with qualitative methods, with a predominance of the qualitative approach. The combination is schematically illustrated in Table 11.

Table 11: Schematic illustration of mixed methods design in the "Theorising" phase based on Huysmans & Verelst (2012); Creswell (2014) and Creswell and Plano Clark (2018)

Huysmans & Verelst (2012)			Creswell (2014); Creswell & Plano Clark (2018)		
Sequential exploratory	Empirical component precedes	EMPIRICAL ->	quan -> QUAL	Investigation with quantitative methods and explanation with qualitative meth-ods, qualitative approach prioritised (case selection variant)	Explanatory sequential
	Design component	DESIGN			

In the "Evaluating" phase, extending the framework of Huysmans and Verelst (2012) a sequential evaluative approach using empirical components to evaluate the design component in two iterations was chosen. The combination is schematically illustrated in Table 12: Schematic illustration of combining methods in the "Evaluating" phase Table 12.

Table 12: Schematic illustration of combining methods in the "Evaluating" phase based on Huysmans & Verelst (2012)

Huysmans & Verelst (2012)				
Sequential evaluative	Empirical component precedes	EMPIRICAL ->	QUAL ->	Design evaluation using qualitative empirical method
	Design component precedes	DESIGN ->		
	Empirical component	EMPIRICAL	QUAL	Design evaluation using qualitative empirical method

The combination of methods led to the following approach, noted according to Creswell and Clark (2018, pp. 62-63) and Huysmans & Verelst (2012):

quan -> QUAL -> DESIGN -> QUAL -> DESIGN -> QUAL

(cf. subsection 5.2.5)

3.2.3 Research Timeframe

The research timeframe can, according to Wilson (2014), have an either longitudinal design, covering a long period of time, or a cross-sectional design, taking part at a (single) point in time.

The research for this thesis was conducted at a single point in time and is thus of a cross-sectional nature according to Wilson (2014).

3.2.4 Data Collection Approaches

In the pragmatic paradigm, qualitative, quantitative, mixed or multiple methods design can be applied for data collection in a Business and Management Research context (Saunders, et al., 2009; Wilson, 2014).

In this thesis, the chosen data collection approaches are, based on the above-mentioned research strategy, a mixture of quantitative and qualitative approaches within empirical social research:
- In the "Theorising" phase, a quantitative online survey was contributing to give indications for the following qualitative setup of problem-centred expert interviews.
- In the "Evaluating" phase, qualitative problem-centred expert interviews and qualitative focus group discussions contributed to the validation of the artefact.

The concrete steps carried out in each individual phase are explained in detail in the corresponding (sub)sections in chapter 4 and the specific research design with the mixture of the collection methods is presented in section 3.3.

3.2.5 Data Analysis Approaches

Following the logic of the above-mentioned data collection approaches, the data analysis also has to be conducted in a multi-method research approach.

In this thesis, the chosen empirical data analysis approaches are, based on the above-mentioned research strategy, a mixture of quantitative and qualitative approaches:
- In the "Theorising" phase, a quantitative descriptive analysis was conducted with the collected survey data, followed by qualitative content structuring of the collected data of the expert interviews according to Mayring (2010) including deductive-inductive hybrid coding according to Bernard et al. (2017), Boyatzis (1998) and Flick (2016) as the basis for the "Building" phase.
- In the "Evaluating" phase, both the qualitative problem-centred expert interviews and the qualitative focus group discussions were analysed using qualitative content structuring of the collected data according to Mayring (2010) including deductive-inductive hybrid coding according to Bernard et al. (2017), Boyatzis (1998) and Flick (2016) as a contribution to the validation of the artefact.

The concrete steps carried out in each individual phase will be explained in detail in the corresponding (sub)sections in chapter 4 and the specific research design with the mixture of the analysis methods will be presented in section 3.3.

3.2.6 Model Construction and Evaluation

Modelling, in the context of Business and Management (Research) and Information Systems (Research) can be described as the discipline of designing and constructing conceptual models (vom Brocke, 2003) by taking "ill-defined and implicit views of reality and cast them in some form well enough defined to be at least understood and argued over by other people" (Pidd, 2009, p. 15) and transferring mental models to artefacts (Schlagheck, 2000; Wand, et al., 1995). The goal is to have a basis for communication between the different disciplines and also for the efficient design of the organisation and/or the information and communication technology, particularly within the complex context of information systems in order to reach an improved future state (Becker, et al., 2012; Frank, 2014; Wilde & Hess, 2006). The act of modelling is thus conducted by (a) modeller(s) with the aim to fulfil a specific goal (DIN, 2000). Models within this context can be developed either deductively (e. g. based on theoretical reasoning), (empirical-)inductively (e. g. based on observation or best practice cases), abductively or by combining the approaches in different states of the modelling construction (Becker, et al., 2003; Bryman & Bell, 2015; Fettke & Loos, 2004b; Habermas, 2008; Richter, 1995; Scheer, 2002; vom Brocke, 2003).

In this thesis, following the Design Science Research Cycle of Gerber et al. (2018) (cf. Figure 19), the research in the "Theorising" phase as the basis for the modelling process was conducted in a rather abductive approach, asking "What could be?". The modelling itself in the "Building" phase was done in a deductive approach, asking "What should be?". The evaluation of the model in the "Evaluating" phase was conducted in a predominantly inductive approach, asking "What is?"

In Business and Management (Research) there are, according to Pidd (2004) and Pidd (2009), two different modelling concepts: The "hard" mathematical modelling and the "soft" modelling approaches, explicitly considering the fact that business is shaped by humans and operates in a very complex, interlinked, evolving environment.

In this thesis, a soft modelling approach according to Pidd (2004) and Pidd (2009) was chosen.

In Information Systems Research, two major streams of modelling concepts can be made out:

- the "illustration-oriented" and
- the "design-oriented" model concepts.

The "illustration-oriented" model concept sees models as objectively perceptible, immaterial, abstract images of reality (Schlagheck, 2000; Thomas, 2006a; vom Brocke, 2003). The "design-oriented" model concept assumes that there is no objective perception of reality and that therefore models are always subjective constructions of modellers for a specific context and/or user at a specific time with the means of (a) modelling language(s) (Braun, et al., 2007; Schlagheck, 2000; Schütte, 1998; Thomas, 2006a; vom Brocke, 2003).

In this thesis, a design-oriented approach according to Braun et al. (2007), Schlagheck (2000), Schütte (1998), Thomas (2006a) and vom Brocke (2003) is used as a basis. Following the design-oriented concept in this thesis, the act of modelling is seen as being (consciously or unconsciously) subjective. The underlying understanding of the modelling procedure of this thesis is illustrated in Figure 20 and can be summarised as: Out of the real-world context, the modeller has to – in a discursive manner – choose an issue to be modelled. After generating a mental model by theorising and interpretation, building (modelling) leads to an explicit model, which has to be reflected with, evaluated by and disseminated to the real world.

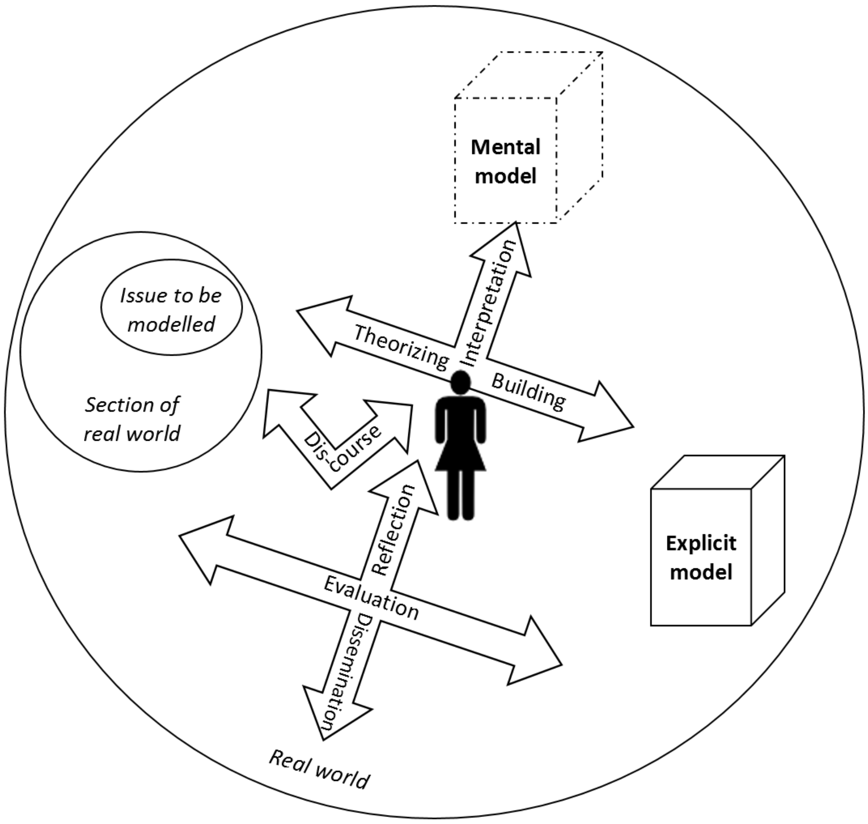

Figure 20: Understanding of the modelling procedure in this thesis based on Delfmann (2006) and Schlagheck (2000).

3.2.6.1 Modelling Methods

The use of the terms “modelling methods” and “modelling techniques” is not unequivocal in literature.

In this thesis, the two terms “modelling methods” and “modelling techniques” are used synonymously.

A modelling method is a framework which specifies the modelling procedure and the use of the modelling language by defining rules in the context of solving modelling problems for one or several model types (DIN, 2000; Prilla, 2010).

Based on Becker et al. (2012) and Prilla (2010), the act of creating conceptual models is declared as complex because of the following necessities and prerequisites:

- the acquisition and explication of, often only in tacit form, available information as well as their systematization and internalization
- the transformation of know-how via a mental model to an external model
- the evaluation and choice of the relevant perspectives and adequate model types and modelling notations
- the theoretical and practical know-how of modelling tools and methods including their conventions
- the alignment of all the involved modelling content (e. g. model architecture, perspectives, objects, attributes, …)

The complexity of modelling is even higher when adding the aspect of time for modelling dynamic systems behaviour (Grochla, 1974; Kruse & Scheer, 1992).

According to vom Brocke (2003), it is important to consider that throughout the modelling process, the model occurs in different states, which leads to the fact that in different phases different objects, contents or modelling forms are relevant. In this context, Braun et al. (2007) emphasize the importance of saving models in different stages in order to be able to retrieve an earlier modelling version if needed.

According to the Design Science Research Cycle by Gerber et al. (2018) (cf. Figure 19), the modelling takes place in the “Building” phase in the two steps of “Identification and proposition of artefacts to solve (a) specific problem(s)” and “Design and (re)development of artefact(s)”.

Following the Design Science Research Cycle by Gerber et al. (2018) throughout this thesis, in the “Building” phase, modelling took place applying
- experience, creativity, principles of form and function and using logic for the step of the identification and proposition of the artefact and
- modelling principles, designing, creativity, collaboration with practitioners and synthesis in the step design and development of the artefact as well as the (re)development of the artefact.

3.2.6.2 Modelling Languages

The detailed context of modelling languages is outlined in subsection 2.6.3.

For the choice of the model language of both the metamodel and the procedure reference model, it turned out to be important to consider a notation which can rather easily be understood by a wide range of stakeholder profiles (cf. subsections 4.1.2.7 et seq.). Therefore, a graph-based notation according to Hars (1994), Grochla (1974), Prilla (2010) and Strecker and Fettke (2014) was chosen. In order to ensure not only an easy understanding, but also a wide acceptability, only standardized and commonly accepted notations were considered.

For the metamodel, the – in business and information systems widely accepted – Modified Entity Relationship Model notation (Modified Chen-Notation) based on Academic dictionaries and encyclopedias (n.d.), Chen (1976), Chen (1981), Chen (1991) and Chen (2002) was chosen (details cf. subsection 2.6.3).

For the procedure reference model and its component models, the – in business and information systems also widely established – notation of Business Process Modelling Notation (BPMN 2.0) based on Allweyer (2010), BPMN Offensive Berlin (2011) and Freund and Rücker (2017) was applied (details cf. subsection 2.6.3).

According to DIN (2000), models and particularly reference models can underlie conventions in language (syntax), layout or content (items, integrations), depending on the context and the goal.

In this thesis, no external conventions had to be taken into account.

3.2.6.3 Modelling Tools

Modelling tools support the design and the construction of models (Delfmann, 2006; EABPM, 2014; Mendling, et al., 2007). There are many different modelling tools that can be applied throughout the whole modelling process. Some examples are

- white / pin boards with paper and presentation cards
- physical or digital drawing tools (e. g. Microsoft Visio)
- modelling software like BPMN-tools (e. g. ARIS toolset)
- different combinations of the above-mentioned

(EABPM, 2014; Fettke, 2009). The European Association of Business Process Management EABPM (2014) points out that with whatever tool is applied, the process should be in the focus and not the tool itself and Frank (2014) emphasizes that the tools should support the interdisciplinary understanding and communication between the different stakeholders of different disciplines. The benefits of the application of software modelling tools are, according to Rosemann (1996) and Strecker and Fettke (2014), the potentially higher model quality due to the reduction of syntactical errors and redundancy, the better integrity, the increased modelling productivity and the broader application potential due to the (automatized) tool support. For selecting the appropriate modelling tool(s), Becker et al. (2012) and Fettke (2009) suggest evaluating the

- possibility to set up the desired modelling perspectives, aspects and architectures,
- cost (including licence and maintenance cost),
- usability,
- complexity,
- support for modelling tasks and
- available know-how.

In this thesis, the digital drawing tool Microsoft Visio was chosen for illustrating the models using the integrated features of a standardized application of the modelling languages.

3.2.6.4 Modelling Principles

Different guidelines of modelling principles and design recommendations including

- relevance
- economic efficiency
- (formal) correctness
- systematic design
- clarity
- comparability
- construction adequacy
- language adequacy

have been developed with the aim

- to increase the quality of models
- to reduce inconsistencies and redundancies
- to ensure completeness and accuracy and
- to enable common, intersubjective interpretation bases

(Becker, et al., 2012; Frank, 2000a; Frank, 2007a; Rautenstrauch & Schulze, 2003; Rosemann, 1996; Schütte, 1998; Shanks, et al., 2003).

Relevance, economic efficiency and (formal) correctness are defined as mandatory or as primary evaluation aspects by Becker et al. (2000) and Rautenstrauch and Schulze (2003) while DIN (2000) emphasize that construction adequacy and language adequacy are primary evaluation criteria as well.

Below, the different principles are explained individually. It is however important to note that the different guidelines shouldn't be evaluated independently as they are interlinked and can influence or hinder each other (Rautenstrauch & Schulze, 2003; Rosemann, 1996; Schütte, 1998):

3.2.6.4.1 Principle of Relevance

The principle of relevance includes the questions, if the

- estimation of the goal and the purpose of orientation is relevant
- object system or modelled elements are relevant
- relevant aspects from the real world were selected to be modelled
- mapping relationships between the real world and the model are relevant
- proposed solution contributes to a current problem
- proposed solution is applicable, accessible and accepted in practice

and can be validated by using economic performance indicators or the assessment of the achievement of previously set goals (Anderson, et al., 2012; Becker, et al., 2000; Becker, et al., 2012; Benbasat & Zmud, 1999; Martensson & Martensson, 2007; Rautenstrauch & Schulze, 2003; Rosemann, 1996).

3.2.6.4.2 Principle of Economic Efficiency

The model itself can hardly be measured for economic efficiency, therefore indirect aspects have to be assessed instead like the relationship between the cost of the model (development, duration of use, sustainability and flexibility for adaptation without fundamental changes of model) and the benefit (increase in revenue) or reduction of cost by applying the model; measures to reach economic efficiency are re-using (reference) models or parts of them, using standardized tools and transferrable notations (Becker, et al., 2000; Becker, et al., 2012; DIN, 2000; Rautenstrauch & Schulze, 2003; Rosemann, 1996; Schütte, 1998).

3.2.6.4.3 Principle of (Formal) Correctness

The principle of (formal) correctness includes syntactic and semantic correctness, semantic consistency and currency and the horizontal and vertical consistency (Becker, et al., 2012; Becker, et al., 2000; Martensson & Martensson, 2007; Rautenstrauch & Schulze, 2003; Rosemann, 1996):

- Syntactic correctness defines the consistency and completeness according to the requirements defined in the metamodel. This implies the existence of a metamodel and, in the "Evaluating" phase, the (independent) assessment of the gap between the ideal model and the logical facts and contexts.
- Semantic correctness means that the modelling structure and the behaviour is consistent with the real world (homomorphy).
- Semantic consistency and currency are hard to be validated.
- Horizontal consistency describes the consistency on a described level within a model.

- Vertical consistency means the consistency between described levels.

3.2.6.4.4 Principle of Systematic Design

The principle of systematic design implies that the model architecture and the metamodel encompass different compatible perspectives and/or views so that the inter-model consistency of structural and behavioural views and the possibility to integrate different component models in a model are given, which requires a metamodel which integrates and defines the different model perspectives (Becker, et al., 2000; DIN, 2000; Rautenstrauch & Schulze, 2003; Rosemann, 1996; Schütte, 1998).

3.2.6.4.5 Principle of Clarity

The principle of clarity deals with the understandability, readability and consumability of a model or rather the different levels of the model according to the targeted user group(s) and includes

- subjective clarity (if the model is clear to one model user (type)) and
- intersubjective clarity (if the model is clear to all model users (user types)

(Benbasat & Zmud, 1999; Martensson & Martensson, 2007; Rautenstrauch & Schulze, 2003; Rosemann, 1996; Schütte, 1998)

Clear models are clearly structured, intuitively understood, well readable and consumable and thus show syntactical simplicity (using as few methodical constructs as necessary) or semantic simplicity (depicting only relevant aspects instead of the complete context including special cases) (Becker, et al., 2000; Becker, et al., 2012; DIN, 2000; Martensson & Martensson, 2007; Rautenstrauch & Schulze, 2003; Rosemann, 1996).

Rautenstrauch and Schulze (2003, p. 256; translated by the author) list the following measures in order to reach simplicity:

- “positioning of the model objects in a grid
- drawing of edges in two orthogonal dimensions
- maximal straightforwardness of the edges
- minimal crossing of edges
- graphical highlighting of correspondences
- arrangement of objects in reading direction
- compliance with naming conventions”

3.2.6.4.6 Principle of Comparability

The principle of comparability is particularly important if the model development is done with divided responsibilities and in Business and Management Research to reach target actual comparison and to compare enterprise-specific and reference models; it can include the recognizability of identities, the equivalences and compatibilities of models on either the metamodel or the model layer with the goal to transfer contents and requires the explicit definition and compliance with conventions and the consistent use of methods (Becker, et al., 2000; Becker, et al., 2012; DIN, 2000; Rautenstrauch & Schulze, 2003; Rosemann, 1996; Schütte, 1998).

3.2.6.4.7 Principle of Construction Adequacy

If there is a clear definition and consensus of the problem, the goal of the model usage, the naming conventions, the content (intention, meaning) and the scope (extension, totality of the items), then the principle of construction adequacy is given (DIN, 2000; Schütte, 1998).

3.2.6.4.8 Principle of Language Adequacy

The principle of language adequacy includes

- the adequacy and problem centredness of a language for the description of a specific context or problem (the problem and the modelling goal define the degree of semantic power of the modelling language),
- the correctness of use of syntax (the syntax has to be defined in the metamodel and complied with in the models; a model is correct, if the language of a model complies with the metamodel),
- the degree of formalization and
- the language intelligibility (which depends on the experience of the model user)

(DIN, 2000; Schütte, 1998).

According to Frank (2000a), modelling languages and notations cannot be falsified. However, according to Fettke (2009), Frank (2000a), Frank (2007a), Herrler (2007) and Schalles et al. (n.d.), modelling languages can be assessed by their:

- expressiveness,
- clarity,
- formal specificity,
- consistency,
- degree of intuitive comprehensiveness, learnability and usability,
- support of multi-perspective modelling,
- reputation and
- degree of support by the means of tools.

Becker et al. (2012) point out that a balance between the comprehensibility and formalization has to be found. Particularly to enable the comparison of models, the freedom of interpretation within the notation has to be limited (Becker, et al., 2012).

In this thesis, the above-mentioned modelling principles of relevance, economic efficiency, (formal) correctness, systematic design, clarity, comparability, construction adequacy and language adequacy are used as a basis for both the model construction and the model evaluation.

As outlined in the research objectives (subsection 1.3.2), Design Science Research strives for reaching epistemological and design objectives. In this thesis, the above-mentioned principles of relevance and economic efficiency are assigned to the evaluation of epistemic objectives while the principles of (formal) correctness, systematic design, clarity, comparability, construction adequacy and language adequacy are chosen to evaluate design objectives.

3.2.6.5 Model Evaluation

The definition of “evaluation” varies, depending on the set goals in the specific context. In general, evaluation can be defined as the act of goal-oriented and purposeful determination of value of something with the means of appropriate, up-to-date methods in order to support planning or decision making (Widmer, 2006; Wottawa & Thierau, 2003). Widmer (2006) points out that evaluation should be useful, feasible, correct and exact, even though very often, evaluation has to meet various, sometimes contradictory expectations.

Scientific evaluation distinguishes itself from everyday evaluation by the fact that experts conduct the evaluation in a systematic and objective procedure with specific, precise criteria on different levels of abstraction or itemization within the specific context and/or for a particular research object (Becker, et al., 2003; Becker, et al., n.d.c; Frank, 2000a; Frank, 2000b; Heinrich, 2000; Riege, et al., 2009; Schmidt & Häntschel, 2000; Stockmann, 2006). The goal of scientific evaluation is to document and rate the research subject’s value or quantity as well as to have a basis to judge in what degree the outcome is suitable for application in a specific context (Heinrich, 2000; Schmidt & Häntschel, 2000). Becker et al. (n.d.c), Frank (2000a), Heinrich (2000), Stockmann (2006) and Widmer (2006) point out that scientific evaluation can hardly be done one-dimensionally but that several aspects have to be considered, applying the appropriate method and if necessary multiple methods.

As the main outcome of Design Science Research (DSR) are artefacts (cf. subsection 2.3.5.2), their quality is the main subject of evaluation (Becker, et al., n.d.c; Frank, 2000a; Österle, et al., 2010). The importance of evaluation of DSR artefacts seems to be obvious, however, several challenges are faced when evaluating DSR artefacts:

- The evaluation has to comply with scientific standards while operating between science and the real-world (Becker, et al., n.d.c; Frank, 2000a).
- Artefacts are hardly ever provable to be true – instead, they have to be evaluated regarding their suitability by experts of the practical and scientific field (Österle, et al., 2010; Frank, n.d.a).
- Even though objectivity of evaluation is a goal in DSR (Becker, et al., n.d.c; Frank, 2000a; Heinrich, 2000), due to the fact that the aim of DSR artefacts is to be useful in a specific context, an evaluation can hardly ever be evaluated in a completely neutral approach and as a consequence, other criteria have to be applied (Frank, 2000a).
- Requirements of artefacts are sometimes competing or opposing each other, e. g. flexibility and integration (Frank, n.d.a).
- Evaluation in a real-world surrounding requires not only a significant amount of time, but also access to adequate experts (Becker, et al., n.d.c).
- The evaluation experts have to fulfil several criteria: they should have the context-specific knowledge, they should be interested to reach a consensus, they should not be persuasive and they should be transparent about their interests while accepting the views of others (Frank, 2000a).
- The choice of the criteria to be evaluated can influence the assessment of utility extensively (Becker, et al., n.d.c; Frank, 2000a).

Particularly within the design-oriented modelling community (cf. subsection 3.2.2.2) where no absolute truth is assumed, a multi-perspective approach of model evaluation is suggested which means that different perspectives have to be included, scrutinized, explained and discussed in correlation with each other in order to reach an assessment according to Becker (2010) and Frank (2007a). As suitable techniques or methods for DSR artefact evaluation, several different approaches can be considered as listed in Table 8. Which combinations of evaluation methods are appropriate has to be reflected and decided upon by the researcher(s) depending on the specific context, also considering

- the effort-benefit-relationship
- the compatibility with existing, comparable research outcomes and/or
- the preferences of the target group

(Becker, et al., n.d.c; Frank, 2000a; Heinrich, 2000; Frank, n.d.a; Österle, et al., 2010). However, Rosemann and Schütte (1999) and Shanks et al. (2003) point out the necessity of involving the adequate stakeholders no matter what methods or techniques are applied.

In the specific context of models (cf. section 2.6), the goal of an evaluation is to measure and/or demonstrate the performance of a developed model compared to set goals, applying assessable and adequate metrics and suitable analysis techniques (Hevner & Chatterjee, 2010; March & Smith, 1995; Meyer & Kenneally, 2012; Peffers, et al., 2007).

3.2.6.5.1 Frameworks for Artefact Evaluation

In terms of evaluation criteria of DSR artefacts, the DSR community for a long time predominantly focused on rigour and relevance aspects (Baskerville, 2007; Benbasat & Zmud, 1999; Hevner, 2007a; Hevner, 2007b; Manson, 2006; Venable, 2007; Winter, 2007; Winter, 2008). A consolidated framework of the discussed ideas, showing the connections between

- Design Science Research
- context / environment
- knowledge base

and their interrelations with

- relevance and
- rigour

are illustrated in Figure 21.

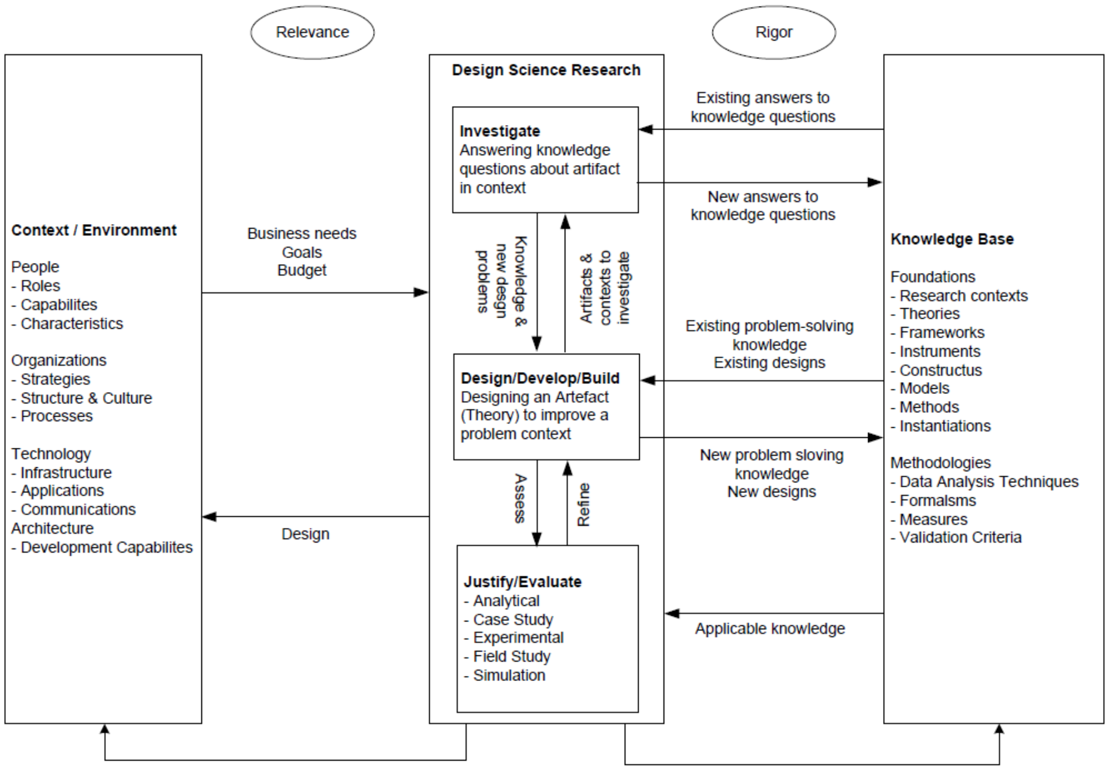

Figure 21: DSR Framework including rigour and relevance based on Hevner et al., 2004 and Wieringa, 2014

Further evaluation aspects were included throughout the development of the discipline. Hevner (2004) added

- utility,
- efficacy and
- viability

as criteria to be assessed. Martensson and Martensson (2007) presented a framework shown in Figure 22.

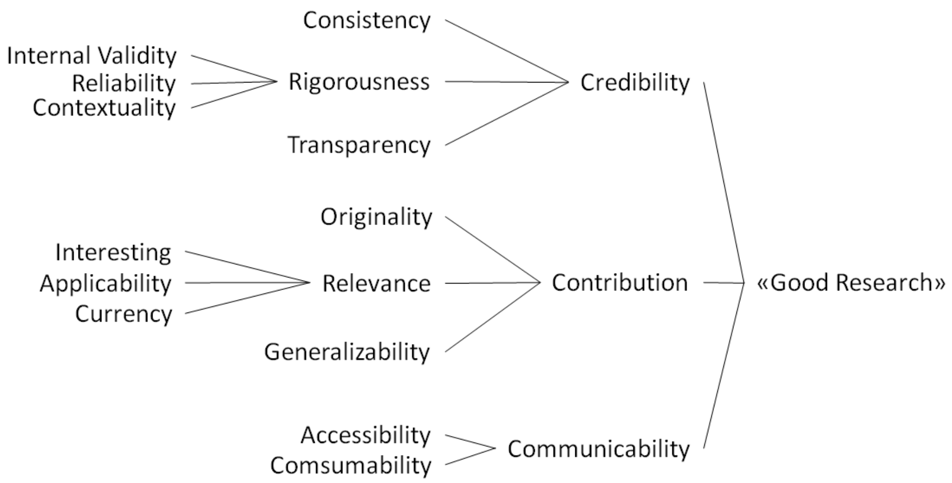

Figure 22: Framework of Research Evaluation according to Martensson and Martensson (2007, p. 1331)

Gerber et al. (2018) consolidate the frameworks – including the guidelines of modelling principles (cf. subsection 3.2.6.4) – and enlarge the evaluation criteria with the evaluation aspects of empirical quality criteria as discussed in section 3.4.

In this thesis, the quality criteria framework by Gerber et al. (2018) was chosen as a basis for the quality assessment of the developed artefacts (as well as the research conducted and the research process of the thesis; details cf. section 3.4).

3.2.6.5.2 Frameworks for Reference Model Evaluation

In terms of reference models (being conceptual models, cf. section 2.6), the above described evaluation aspects also apply (Fettke & Loos, 2003a; Frank, 2000a; Frank, 2007a). However, Frank (2007a) points out that the evaluation of reference models is challenging, due to the fact that

- it can be costly if not unaffordable to evaluate the various aspects in different reference-context(s) – particularly in a long-term view and
- correlations between the model applications, the subjectivity of the different model users and the economic context of businesses can hardly, if at all, be evaluated.

Frank (2007a) therefore suggests a pragmatic multi-perspective framework for evaluating reference models, including the following evaluation perspectives:

- economic perspective
- deployment perspective
- engineering perspective
- epistemological perspective

The framework for the evaluation of reference models is summarised in Table 13.

Table 13: Framework for the evaluation of reference models based on Frank (2007a)

Perspec-tive	**Focus**	**Aspect**	**Criteria to be evaluated**
Economic	Costs / Introduction	Acquisition	Cost of purchasing, licensing and in-house development; Economies of scale
		Training	Familiarity of own staff with modelling language/terminology; in-house modelling expertise; Availability of training offers; Overall complexity of model
		Adaptation	Availability of concepts that support adaptation in a safe and convenient way; Availability and cost of tools; Cost of integrating with existing tools/systems
		Strategic re-design	Degree of required change / strategic adaptation
		Organisational re-design	Degree of required change and organisational adaption
		Integration	Degree of required integration with existing models and business partners; Degree of compatibility of modelling concepts
	Costs / Transformation and analysis	Suitability	Degree to which modelling concepts allow for automatic transformation into implementation level documents; Degree of support of the modelling concept for the required types of analysis; if necessary: cost for adapting the model for transformation/analysis
		Tools	Availability and cost of tools that feature transformation/analysis functions; Cost of integrating tool with existing software development environment
		Training/Support	Availability of skills required for performing transformation/analysis tasks; Cost of training and external support
	Costs / Maintenanc	Conceptual support	Availability of concepts that support adaptation in a safe and convenient way
		Tools	Availability and cost of tools that support model management (versions, users)
		Skills	Cost of internal and external skill

Continued

Table 13: Framework for the evaluation of reference models based on Frank (2007a) - Continued

Perspec-tive	Focus	Aspect	Criteria to be evaluated
	Benefits / Efficiency/effectiveness	Software development and maintenance	Degree of improvement of productivity and software quality; Degree of functionality and maturity of available tools; Degree of compatibility with existing abstractions; Skill level of software developers and degree of willingness to use reference model
		Business/Management	Amount of increased efficiency of affected business processes; Amount of cost reduction within business processes; Availability of support for specific decision scenarios; Familiarity with model based decision making; Degree of willingness to use model within decision scenarios; Degree of improved customer-orientation
	Benefits / Flexibility/integration	Dependence from IT-vendors	Number of relevant IT-vendors that support model and number of users; Degree of customization and standardisation; Level of industry commitment
		Openness	Degree of compatibility to relevant standards; Degree of possibility of integration with further reference models; Coverage of possible future business models
		Expressive power	Degree of (ontological) completeness of modelling language
		Relationship to other IT artefacts	Availability of concepts that foster integration/transformation into other relevant representations
	Benefits / Coordination/knowledge	Coordination	Degree of helping to overcome communication barriers within company; Degree of fostering communication with external partners, to improve coordination of business processes and the establishment of inter-organisational coordination
		Knowledge management	Degree of contribution to internal dissemination of relevant knowledge, to cross-organisational exchange of knowledge and towards a unified, enterprise-wide terminology; Degree of supporting the development of relevant skills of employees, incorporation of relevant, external knowledge and the decrease of time to bring new employees and business partners up to date
	Protection of investments	Spreading/Commitment	Number of organisations that use the model, number of vendors and service providers that support the model; Degree of standardisation of modelling language and model
		Technological change	Degree of independence from a particular technology and supporting technologies that can be expected in near future
Deployment		Understandability	Degree of elaboration of structure for documentation (e. g., with design patterns), comprehensiveness of documentation; Availability of scenarios and examples; Degree of familiarity with modelling language and terminology and intuitive access to graphical representation; Availability of views for different groups of stakeholders
		Appropriateness	Amount of support for purposes relevant for users; Degree of support of technologies that can be expected in near future
		Attitude	Degree of “Not invented here”- syndrome, of reputation of model developers, of resistance towards organisational change and cultural barriers

Continued

Table 13: Framework for the evaluation of reference models based on Frank (2007a) - Continued

Perspective	Focus	Aspect	Criteria to be evaluated
Engineering		Definition	Degree of comprehensiveness of description of intended application domains and purposes
		Explanation	Degree of assessing model elements to requirements, of justification/substantiation of design decisions, of discussed design compromises and resulting drawbacks and of alternative approaches
		Language features	Level of formalization, extensibility, supported conceptual views, integration of views, tool support, concepts to support the adaptation of models and concept to foster model integrity
		Technical model features	Degree of formal correctness/consistency, of model architecture, of use of classes, of generalisation/specialisation and of modularisation/encapsulation
Epistemological		Evaluation of theories	Degree of precision of description of core concepts with respect to corresponding real-world concepts and of underlying assumptions
		Generic principles	Degree of abstraction, originality and judgement
		Critical distance	Degree of subjective nature, underlying decisions and bias through familiarity with modelling language
		Scientific progress	Availability of discussion of long-term goals of research and comparison with alternatives; Degree of elaboration of documentation of model with respect to generic principles and long-term research goals

As the objective of this thesis is to develop a reference model (cf. section 1.3), in this thesis, a combination of the "Framework for the evaluation of reference models" by Frank (2007a) as well as the modelling principles described in subsection 3.2.6.4 were used as a basis for evaluating both the design objectives and the epistemic objectives of the procedure reference model (cf. subsection 1.3.2). Details cf. Appendices 7 - 9.

3.2.7 Summary of Methodological Position including Artefact Evaluation Principles

Figure 23 illustrates the summary of the methodological position of this thesis based on Wilson (2014, p. 117). Following the basic belief of pragmatism, the ontologically and axiologically open position, the epistemological pluralism and the consensus theory (cf. section 3.1)

- the research approach was chosen depending on the specific need for the different steps and can be of inductive, deductive as well as abductive nature
- the research strategy follows a method pluralistic combination of empiricism and Design Science Research
- the time horizon is cross sectional
- the applied empirical data collection methods are of quantitative (survey) and qualitative (expert interviews and focus group discussions) nature
- the empirical data analysis includes descriptive analysis for the quantitative part and the classification approach of content structuring within the context analysis approach for the qualitative parts
- the artefact construction is done by using (soft) modelling principles, applying the Modified Entity Relationship Modelling Notation (ERMN) for the metamodel and the Business Process Modelling Notation (BPMN) for the procedure reference model and its component models; for the evaluation, the framework for reference model evaluation is applied

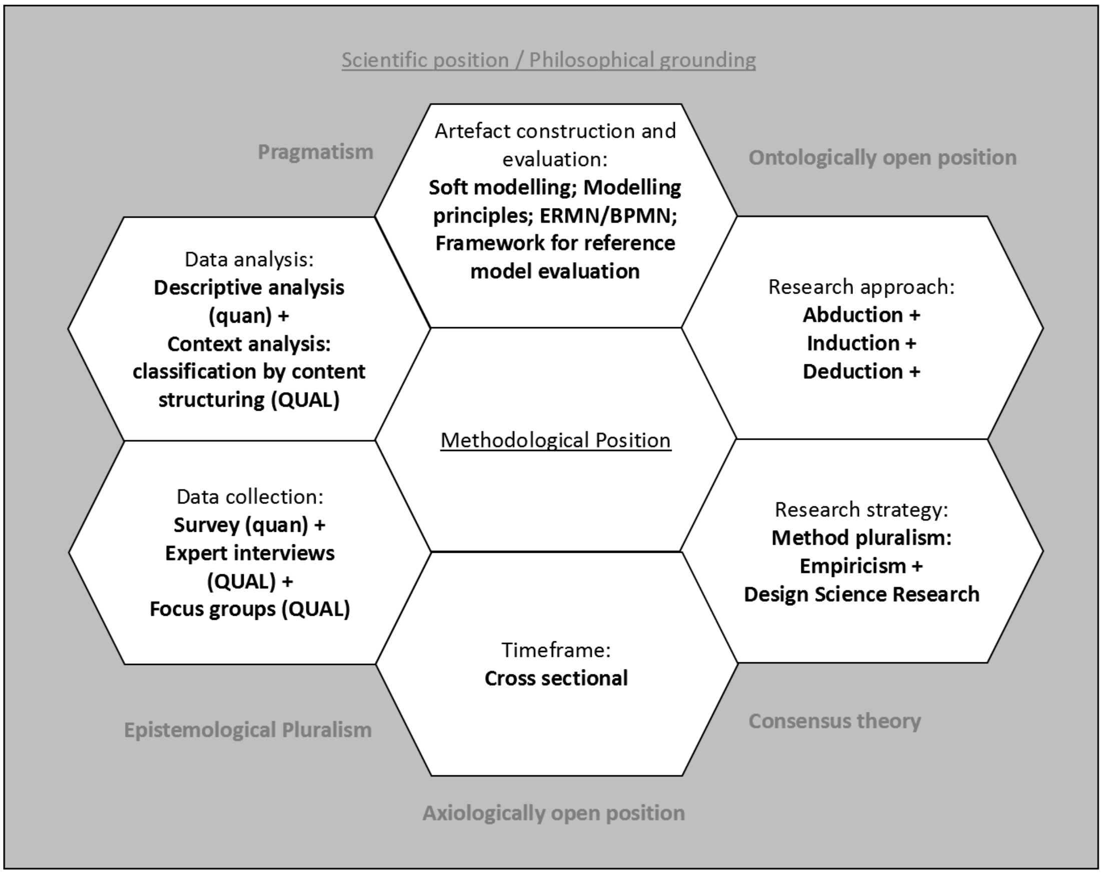

Figure 23: Summary of methodological position aligned with the scientific position / philosophical grounding as described in section 3.1 based on Wilson (2014, p. 117).

Based on the pragmatic philosophical grounding combined with design-oriented research principles (cf. section 3.1 and subsection 3.2.2.2), in terms of evaluation, this thesis follows the approach of argumentative evidence (convincing argumentation, comprehensibility of logical chain, plausibility and transparency of research design and derivation of results) before empirical (statistical) evidence according to Becker (2010).

Overall, the justification of evaluation is guided by the understanding of Becker (2010), Becker et al. (2003), Frank (2000a) and Österle et al. (2010) who argue that the evaluation of DSR artefacts requires power of judgment and awareness and appreciation of the coherent whole:

- Is the research design adequate?
- Do the research method(s), the research goal and the scientific grounding match?
- Is the argumentation convincing and the justification comprehensible?
- Is the approach and the derivation of the outcome transparent?
- Were the adequate experts involved?

(cf. section 5.2)

3.3 Derivation of Research Design

As a basis for this thesis' research design setup, the principles of the Design Science Research Cycle for Business and Management Research and Development Projects by Gerber et al. (2018) presented in subsection 3.2.2.2 was chosen, adding the “Ten Guidelines for Drawing Procedure Diagrams for Mixed Methods Studies” by Creswell and Plano Clark (2018, p. 64):

1. Give a title to the diagram.
2. Choose either a horizontal or a vertical layout for the diagram.
3. Draw boxes for the quantitative and qualitative stages of data collection, data analysis, and interpretation of the study results.
4. Use uppercase or lowercase letters to designate the relative priority of the quantitative and qualitative data collection and analysis.
5. Use single-headed arrows to show the flow of procedures in the design.
6. Specify procedures for each stage of quantitative and qualitative data collection and analysis.
7. Specify expected products or outcomes of each procedure in quantitative and qualitative data collection and analysis.
8. Use concise language for describing the procedures and products.
9. Make your diagram simple.
10. Limit your diagram to a single page.

Figure 24 illustrates the overall research design of this thesis.

- The purple elements represent the Design Science Research (DSR) approach,
- the blue elements the empirical mixed methods approach,
- the grey elements other approaches.
- The white elements represent the outputs of the different steps.
- The solidly delineated arrows indicate a mandatory step in the course.
- The dashed arrows indicate potential iterations, depending on the effective outcomes and development of the research.

Based on this initial framework, the illustration of the research design was continuously specified throughout the thesis as shown in Figure 33, 53 and 55 and in a sequential manner in Figure 57.

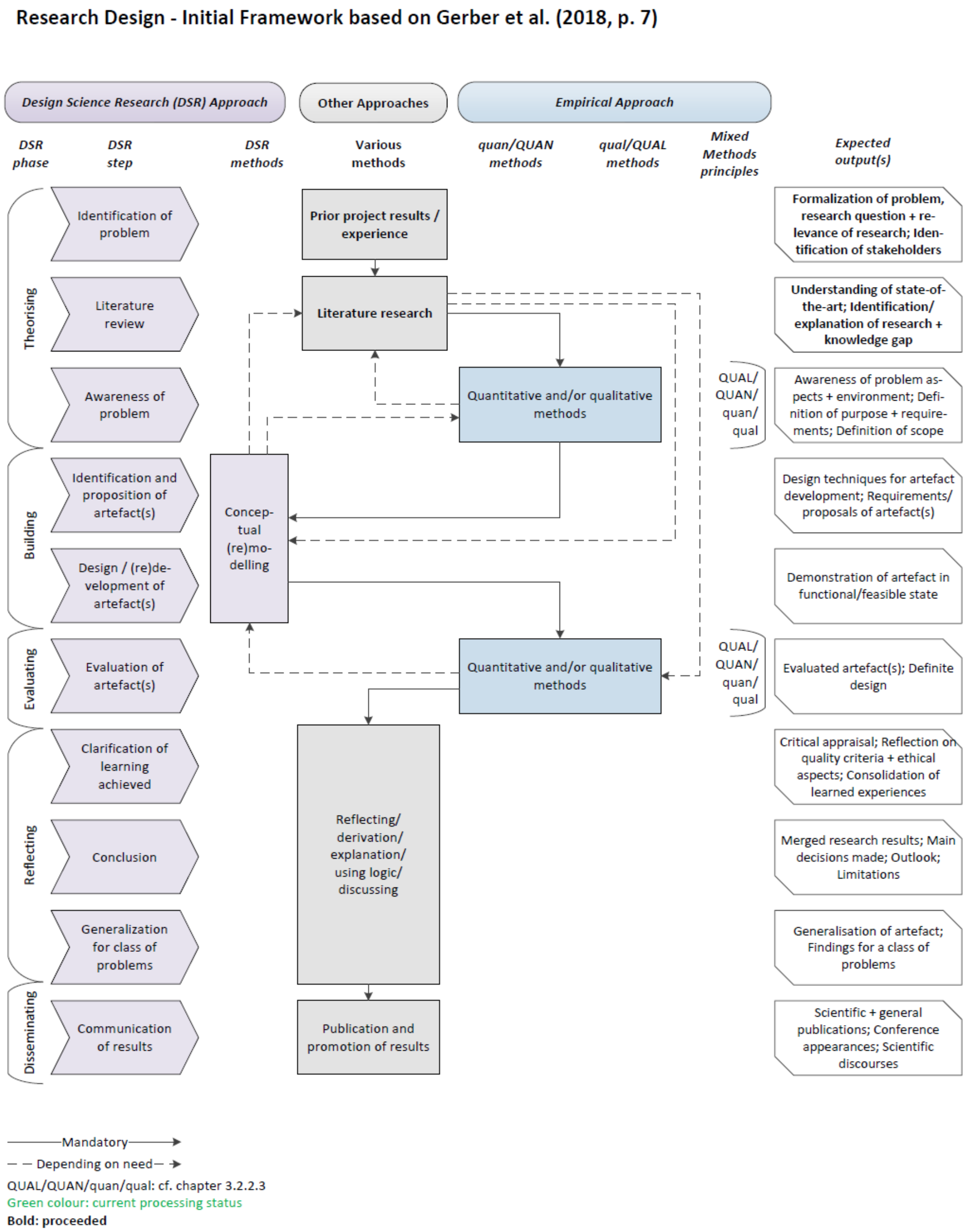

Figure 24: Illustration of Overall Research Design

3.4 Applied Quality Criteria Framework

As mentioned in subsection 3.2.6.5.1, the quality criteria framework by Gerber et al. (2018), based on Barbour (2009), Boyatzis (1998), Brinkmann and Kvale (2015), Flick (2007), Flick (2016), Mason (2002), McLeod (2011), Saunders et al. (2009), Stahl (2009) and Wilson (2014) was chosen as a basis to assess the quality of the developed artefacts, the research conducted as well as the research process overall. The content of the framework is listed in Table 14.

Table 14: Summarised quality criteria framework for DSR artefacts in Business and Management Research based on Gerber et al. (2018, p. 10)

1st level criteria	2nd level criteria	Approa-ches	Aspects included
1 Credibility	1.1 Integrity/ trustworthiness		Ethical considerations
			Sensibility of method pluralistic research designs
			Participant feedback / member checks
	1.2 Contextual rigour	1.2a Quan	Objectivity
			Reliability
			Validity
		1.2b Qual	Intersubjective transparency
			Indication
			Empirical anchoring
			Limitations
			Reflecting subjectivity
			Coherence
			Openness to diversity
			Discourse
		1.2c DSR	Utility
			Practicability
			Viability
2 Contribution	2.1 Relevance		of research question
			of presented (generalizable) problem solving/improvement/innovation
			impact and contribution
	2.2 Communication		Degree of accessibility/transparency
			Degree of fitness for target group
			Degree of reduction of academia-practice gap

Based on the quality criteria framework by Gerber et al. (2018), in this thesis, the following questions are chosen for a systematic and encompassing research quality assessment:

1. Can the research in this iteration be trusted?

1.1 Does the researcher demonstrate trustworthiness, integrity, honesty and fairness in the processes and actions in this iteration?

1.1.1 Were ethical principles considered in this iteration? (Is the research legitimate? Does the researcher describe the necessity of the research, the research goal, motivation and methodology, the access to and the management of data? Is the estimation and honesty of possible harm by research activities and prevention measures considered, the source stringency and style of conducting interviews and asking questions reflected, accuracy ensured, the data protection regulations and legal requirements like confidentiality, anonymity, data protection, informed consent followed? Does the researcher ensure the transparency on relationship with interested parties with respect to results and potential commercial interest or conflicts of interest, own experience, values, background and intentions? Does the researcher show respect, professional conduct towards all stakeholders? Does the researcher consider the safety of other researchers, the wider community and her own safety? Does the researcher check the need for approval of dissemination? Does the researcher

show sensibility to dependencies and role/relationships and positive or negative impacts for participants involved? Does the researcher include full (de)briefing of participants about research context and their rights?)
1.1.2 Was sensibility to the method pluralistic research design demonstrated? (Were the implications of the combination and interlinking of multiple methods, disciplines and perspectives considered, the controversies between rigour and creativity, consistency and flexibility, transparency and indication discussed, the breadth and depth of methods balanced, were open positions and a multi-perspective concept of truth in order to embrace possibly rather new research design combinations taken, was a certain openness for multiple world states and diversity shown, were the controversies between rigour and creativity, consistency and flexibility, transparency and indication discussed, were more iterations in order to find the necessary parts of the method mix allowed, did the researcher show the courage to try new approaches and thus the readiness to be in discourse and reflection with different stakeholders, leading to a need for a higher tolerance for ambiguity?)
1.1.3 Were credibility checks, member feedbacks, member checks applied in this iteration?
1.2 Does the research show contextual rigour in this iteration? (Are the knowledge, theories and research methods effectively used?)
1.2a Quantitative approaches
1.2a.1 What is the degree of objectivity in this iteration? (What is the degree of independence of the researcher and the external factors? What is the objectivity of application, of analysis, of interpretation?)
1.2a.2 What is the degree of reliability in this iteration? (What is the extent that results remain consistent when replicating the same procedures? What is the retest/external, the parallel test, the internal, the split-half, the inter-coder reliability?)
1.2a.3 What is the degree of validity in this iteration? (How appropriate is the measuring method used to measure the intended construct? What is the content, the criterion, the predictive, the construct, the internal, the external, the ecological, the sampling/population, the face validity?)

1.2b Qualitative approaches
1.2b.1 Was intersubjective transparency demonstrated in this iteration? (Are the research results of explicitly transparent and documented and thus comprehensible and verifiable? Does the research demonstrate underlying understandings and personal anticipations, show personal involvement, reveal details about the survey and analysis, methodologies and contexts like transcription rules or data and information sources, discuss decisions, challenges and criteria, reveal reflections and knowledge gained, disclose the application of codified procedures, explain the rhetorical structure?)
1.2b.2 Was indication and justification demonstrated in this iteration? (Is the qualitative approach within the research question indicated and justified, are the method selection, the transcription rules, sampling strategies, the methodological decisions, the evaluation criteria and the evaluation criteria indicated, are the appropriateness of the method choice and development, the evaluation criteria, the grounding in examples, the efficacy and efficiency of the sample, the overall research pragmatism justified?)
1.2b.3 Was empirical anchoring done in this iteration? (Are the theories formed with codified procedures and evaluated with documented empirical principles?)
1.2b.4 Are limitations within the whole context under the relevant conditions described?
1.2b.5 Was subjectivity reflected in this iteration? (Is the research process reflected, the personal prerequisites and dependencies, the professional prerequisites and dependencies, the oscillation between approximation and distance of the research context, the relationship between the researcher and the respondents, the researcher’s own motivation?)
1.2b.6 Was internal and external coherence demonstrated in this iteration? (Does the researcher demonstrate comprehensibility, deal with and integrate contradictions in a sensible manner, balance methodology and design, demonstrate clarity and power of argumentations?)

1.2b.7 Was openness to diversity demonstrated in this iteration? (Does the researcher show openness to diversity? How are the different upcoming scientific and personal challenges handled, the contradictions and dissonances between rigour and creativity as well as contradictions and dissonances between consistency and flexibility coped with?)
1.2b.8 Was discourse conducted in this iteration? (Does the researcher discuss and exchange with readers, with the scientific community, with other stakeholders in an appropriate manner? Does the researcher discourse competing explanations and interpretations of the results / throughout the process?)

1.2c DSR Approaches
Was the degree of utility, practicability and viability of DSR artefacts assessed in this iteration? (Does the researcher demonstrate the completeness and effectiveness, the utilisation, the satisfaction of the needs of the users, the problem-solving of the artefact, the application of modelling principles of relevance, economic efficiency, correctness, the systematic design, clarity, construction adequacy, language adequacy)

1.2d Research overall
Does the research show contextual rigour? (Are the knowledge, the theories, the research methods effectively used?)

2. Is the research contributory?
2.1. Is the research relevant?
2.1.1 Is the research question relevant? (What is the degree of the current interest, what the adequacy of the research?)
2.1.2 Is the presented (generalisable) problem solving / improvement / innovation / overall theory relevant? (What is the relevance of the presented generalizable problem solving? What is the degree of improvement in innovation and/or in theory?)
2.1.3 What is the degree of impact and contribution of the research?
2.2 Is the research communication contributory?
2.2.1 What is the degree of accessibility / transparency of the research? (Are the research results accessible, are they clear, understandable, concise, presented in a structured writing style? Are the research results transparent?)
2.2.2 What is the degree of fitness for target group? (Does the research show fitness to the technology- and management-focused academic and practical context, in the written and in oral presentational context?)
2.2.3 What is the degree of reduction of academia-practice gap? (In what degree does the research reduce the gap between academia and practice?)

In this thesis, the above mentioned quality criteria were applied as follows:

For the critical reflection of every iteration (cf. subsections 4.1.1.9, 4.1.2.9, 4.2.2.7, 4.2.3.4, 4.3.1.9, 4.3.2.9)
Credibility:

- Integrity/trustworthiness
  - Ethical considerations in this iteration
  - Sensibility of method pluralism in this iteration
  - Participant feedback / member checks in this iteration)
- Corresponding contextual rigour of every iteration

Overall (cf. section 5.2)

Credibility:
- Integrity/trustworthiness
  - Ethical considerations in this iteration
  - Sensibility of method pluralism in this iteration
  - Participant feedback / member checks in this iteration)
- Overall contextual rigour

Contribution:
- Relevance of research

- Relevance of research question
- Relevance of presented problem solving / improvement / innovation
- Relevance of impact and contribution

- Communication of research

- Degree of accessibility / transparency
- Fitness of target group
- Reduction of academia-practice gap

In addition, when – like in this thesis – conducting research involving different languages, the impact of translation issues must be considered and made transparent, including the translation procedure and techniques, so that this fact can be considered in the assessment of the research project and its results (Birbili, 2000; Esposito, 2001; Larkin, et al., 2007). Depending on the context, the use of different languages can produce misunderstandings, challenges and errors in interpretation and translation because of the fact that certain descriptions or terms do not exist or have a different meaning in another language context (Birbili, 2000; Esposito, 2001; Temple, 2004). Esposito (2001) points out that qualitative research methods are even more affected by this fact than quantitative methods. According to the research context, the methods of data collection, analysis and dissemination and the corresponding language issues have to be chosen (Esposito, 2001). Baumgartner (2012) points out the following issues when deciding on languages to use:

- Determination of inquiry language of all interviews, dependent on mother tongue of interviewer and participants
- Determination of language of the data analysis subdivided into the steps familiarization of the material, the data handling and the conclusion and dissemination.

According to Esposito (2001, p. 570), translation is defined as "the transfer of meaning from a source language […] to a target language […]". According to Birbili (2000) the quality of translations is not only influenced by the fluency of language, translating competency, the knowledge of the context under study and the autobiography of the person translating (researcher her-/himself or other people), but also by the relationship of the translating person towards other people involved in the research process.

In this thesis, the inquiry language chosen is (Swiss) German due to the fact that the mother tongue of both the sample and the researcher is (Swiss) German. Because the language of this thesis is English, the data analysis was conducted in English.

A translator is, according to Esposito (2001, p. 570), "an interpreter who, when faced with a communication task such as a statement or conversation, processes the vocabulary and grammatical structure of the words while considering the individual situation and the overall cultural context of the [Source Language]." The decision of who translates depends on the involved language skills of the researcher and the available funding (Temple, 2004). Temple (2004, pp. 167-168) points out that if researchers see themselves as neutral and objective transmitters of messages, as discussed above, the translation act itself poses technical issues that can be overcome. If the researcher is objective it does not matter if they carry out the translation or if someone else does it.

The author of this thesis has lived in English-speaking countries, is in possession of a Cambridge Proficiency diploma, writes, presents and lectures in English so that the language skills for processing the translations were judged as sufficient. This in combination with the fact that the author sees herself as neutral towards and independent from the research outcome, the translations of the collected data from German to English was conducted by the researcher herself.

What also has to be decided is, if the translation should be literal or free. According to Birbili (2000) a literal (word-by-word) translation stays true to the verbal statements but can reduce the readability while the goal of the free translation is to reach readability, however departing from the original spoken word but potentially losing information.

Following the goal of the thesis to develop a procedure reference model as an artefact, original quotes or linguistic particularities were not the focus of the thesis but much more the assessment of the general context and the understanding and relationships between aspects as a basis for the model development – which involves the reduction to the main aspects anyhow (cf. subsections 4.1.1.9, 4.1.2.9, 4.3.1.9 and 4.3.2.9). Due to this fact, a free translation according to Birbili (2000) was chosen.

In order to overcome challenges in the context of translation and to mitigate risks of misinterpretations, Baumgartner (2012), Birbili (2000) and Esposito (2001) suggest

- back translation (from the source language to the target language and back) in order to detect differences
- consulting other people from the field or native speakers discussing the meanings of words.

In this thesis, German terms not existent in English were discussed with experts in the field and the language service staff.

4 Research and Modelling Conducted

In this chapter, the research and modelling conducted within this thesis are presented. Figure 25 shows chapter 4 in the context of the whole thesis.

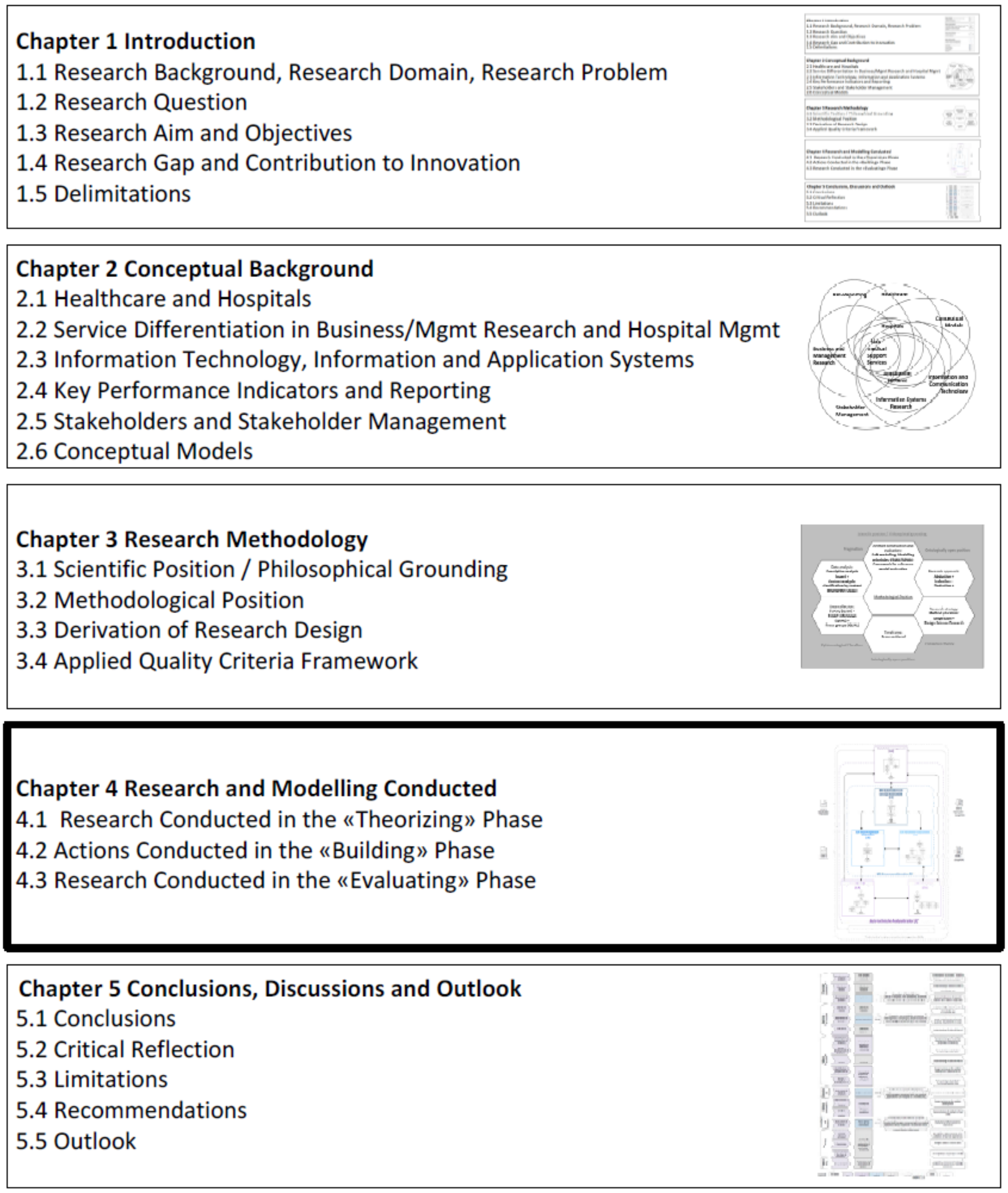

Figure 25: Context of chapter 4 within the whole thesis

The research and modelling conducted in this thesis will be presented along the DSR phases “Theorising”, “Building” and “Evaluating” (cf. Figure 24).

4.1 Research Conducted in the “Theorising” Phase

In this section, the research conducted in the “Theorising” phase is presented. The methods were chosen to reach a higher degree of awareness of the problem and a clearer formalization of the aspects of the problem according to Gerber et al. (2018). To reach this goal, first, a quantitative survey was conducted in order to get a deeper understanding of the current situation of non-medical applications in Swiss hospitals. In a second step, qualitative expert interviews were conducted in order to obtain the necessary information as a basis for the development of the procedure reference model. The conducted steps will be presented in detail in the following (sub)sections.

4.1.1 Research Conducted in the First Iteration of the "Theorising" Phase

In this subsection, the research undertaken in the first iteration of the "Theorising" phase is explained. The goal of the initial iteration was to understand the environment better and to become more aware of the problem about the current situation of non-medical software applications in hospitals. An additional intention was also to sensitise the target population in order to gain access to experts for the following research steps. The research undertaken in the first iteration of the "Theorising" phase was, according to Mayer (2009, p. 58), following the steps "sampling", "measurement model with hypotheses", "operationalisation", "questionnaire", "pre-test", "conducting survey", "analysis" and "reporting", adding "critical reflection" as illustrated in Figure 26.

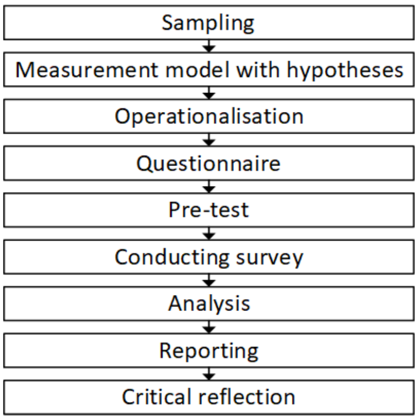

Figure 26: Conducted research steps in the first iteration of the "Theorising" phase based on Mayer (2009, p. 58, translated by the author)

The steps will be discussed in detail in the following subsections.

4.1.1.1 Target Population, Sampling and Response in the First Iteration of the "Theorising" Phase

In this very first iteration, the intention was to assess the relevance of the research question. The goal was therefore to question experts in hospitals that likely have at least an average length of experience in terms of handling information systems and application integration in order for them to be able to provide the information about alignment and integration of applications needed for this thesis. The sampling strategy was therefore to approach a sample with high intensity according to Flick (2007). From the author's experience, hospitals running an ERP system of SAP are likely to fulfil this criterion. Thanks to previously conducted research and development projects, it was possible to obtain the contact information and thus access to all 22 members of the Swiss SAP Usergroup in Hospitals (SSAGK), representing all the different hospital categories (centrum care, primary care, psychiatric clinics and rehab/special clinics) as listed in subsection 2.1.2.5.2. By proceeding in this manner, a purposeful intensity sampling according to Patton (1990, p. 182) defined as "information-rich cases that manifest the phenomenon intensely, but not extremely" was applied. The targets were ICT staff and ICT managers involved with managing non-medical software applications in hospitals and thus representing their specific professionalization according to Flick (2016).

4.1.1.2 Measurement Model with Hypotheses in the First Iteration of the "Theorising" Phase

In terms of scope of non-medical support services, the whole range of non-medical support services in hospitals according to Gerber (2016) was chosen, covering

- Logistics (Procurement: Warehousing, Transport & Provision, Disposal & Recycling)
- Infrastructure (Maintenance, Space Management, Energy)
- Facility Services (Safety & Security, Cleaning, Sterilization)
- Hospitality (Catering, Textiles, Operation of Accommodation & Operation of Properties, Hotel Services Diverse).

In terms of integration and alignment aspects, the criteria used by Linthicum (2000), Themistocleous and Irani (2002) and van den Bosch (2010) were chosen as a basis for the measurement model, including the topics

- integration styles
- layers of integration
- form of the solution
- degree of integration
- chosen target applications

4.1.1.3 Operationalization in the First Iteration of the "Theorising" Phase

The operationalization was deductively chosen according to the above-mentioned research of Linthicum (2000), Themistocleous and Irani (2002) and van den Bosch (2010), complemented with open questions allowing to add own dimensions or remarks about the topics:

- Types of integration mechanisms implemented or planned (EAI / File transfer / Shared database / Remote procedure / Messaging / Web services / Other integration mechanisms, namely: / No information/not known / Remarks:)
- Integration layer of implemented or planned (Connectivity / Transportation / Translation / Process automation / Other integration layer, namely: / No information/not known / Remarks:)
- Form of solution applied or is planned (Integrated product / Toolkit application / Other form of solution, namely: / No information/not known / Remarks:)
- Degree of integration (coupling) chosen or planned (tight coupling / loose coupling / No information/not known / Remarks:)
- Target applications chosen or planned (Standard application/purchased software / Customer specific application/in-house development / No information / not known / Remarks:)

4.1.1.4 Questionnaire for the First Iteration of the "Theorising" Phase

The questionnaire developed according to the above-mentioned bases was set up in the online survey tool "2ask". Appendix 1 displays the introduction part visible for all participants, selecting the non-medical support services to be continued with. Thereafter, the following questions appeared

- Which integration mechanisms of the application integration was conducted or is planned in the area of xy?
- On which integration layer was the application integration in the area of xy conducted or is planned?
- Which form of solution was applied or is planned?
- Which degree of integration (coupling) was chosen or is planned?
- Which target application was chosen or is planned?

with the above mentioned operationalisations as possible selection for all the subject-areas indicated in the first step.

As a basis, all selection combinations had to be programmed as shown in Appendix 2.

4.1.1.5 Pre-test in the First Iteration of the "Theorising" Phase

The questionnaire was discussed with two ICT experts. One general ICT expert was asked to give feedback about understandability and correctness of the content in general and one ICT-in-hospitals expert was asked about the need for adaptations in order to be understandable within the hospital context.

4.1.1.6 Data Collection in the First Iteration of the "Theorising" Phase

The survey was conducted with the online survey tool "2ask". The mail was sent to the SSAGK distribution list with information about the context, the instructions about how to proceed, the official LJMU participant information and the link to the survey. Three parties responded that they had no capacity for filling in the form, for one person the successor could not yet be named at the time. For the rest of the sample, a reminder mail kindly asking to participate was sent after two weeks. Finally, six experts participated. The answers given were exported from "2ask" in order to be analysed and processed.

4.1.1.7 Descriptive Data Analysis in the First Iteration of the "Theorising" Phase

The basis for the data analysis was the collected data out of the online survey tool "2ask". One example of the extracted data from "2ask" is displayed in Appendix 3. The quantitative data analysis has to be put in its context (cf. Gerber et al., 2018). With the collected data from six participants out of a population of 22, no reliable statistical analysis was possible. The analysis is therefore purely of descriptive nature.

In terms of non-medical subject areas, the question was asked, if application integration measures had been conducted during the past five years or were currently planned (cf. Appendix 1). As Figure 27 shows, there are numerous indications about conducted or planned integration projects within different non-medical subject areas in hospitals.

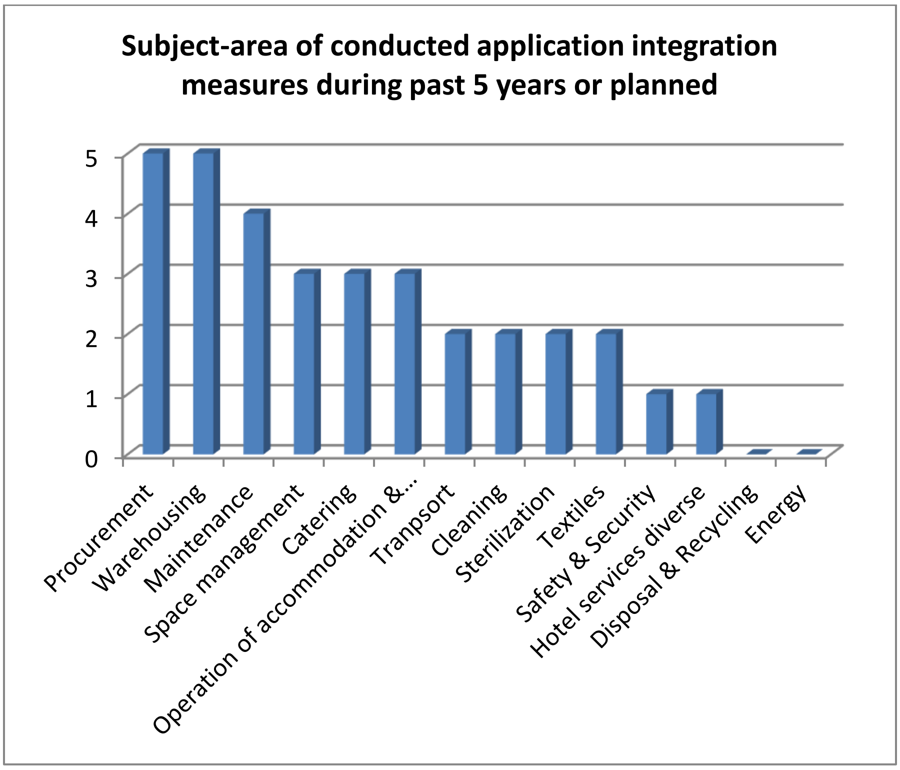

Figure 27: Subject-area of conducted application integration measures during past 5 years or planned

The frequency of the indicated subject areas turned out to be very similar to the prioritization of the non-medical support services in hospitals found by Gerber and Hofer (2017a). Application integration in the subject-areas of Procurement, Warehousing, Maintenance, Space Management, Catering and Operation of accommodation & Operation of properties were indicated repeatedly. Application integration in the subject-areas of Transport, Cleaning, Safety & Security, Sterilization, Textiles and Hotel Services Diverse were indicated with a lower intensity. Application integration in Disposal & Recycling and Energy had not yet been a topic in any of the participating hospitals.

The next question was, which integration mechanisms of the application integration had been conducted or were planned in the different non-medical support services. As Figure 28 shows, file transfer was applied in all participating hospitals. Further applied mechanisms were messaging, web services, shared databases, remote procedures, service oriented architecture (SOA) and other integration mechanisms, as well as combinations of mechanisms. It became clear that an individual and more detailed observation had to be applied in order to be able to reach a differentiated clarification in this regard.

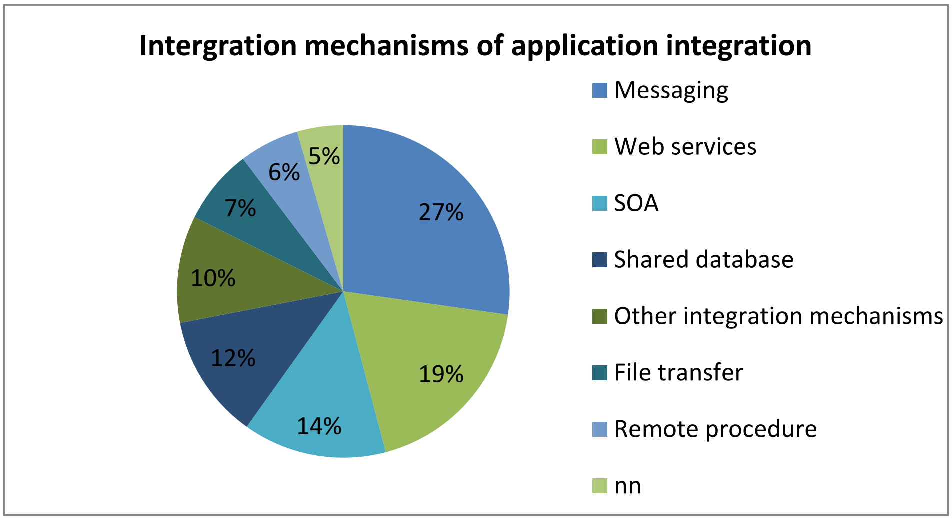

Figure 28: Integration mechanisms of application integration

The third question was, on which integration layer the application integration in the different non-medical subject-areas had been conducted or was planned at the time. In the participating hospitals, in most subject-areas, application integration had been done or was planned on the layer of connectivity, transportation and process automation, but also translation and combinations of different levels were indicated (cf. Figure 29). Here again, it became clear that an individual and more detailed observation had to be applied to be able to reach a differentiated clarification if necessary.

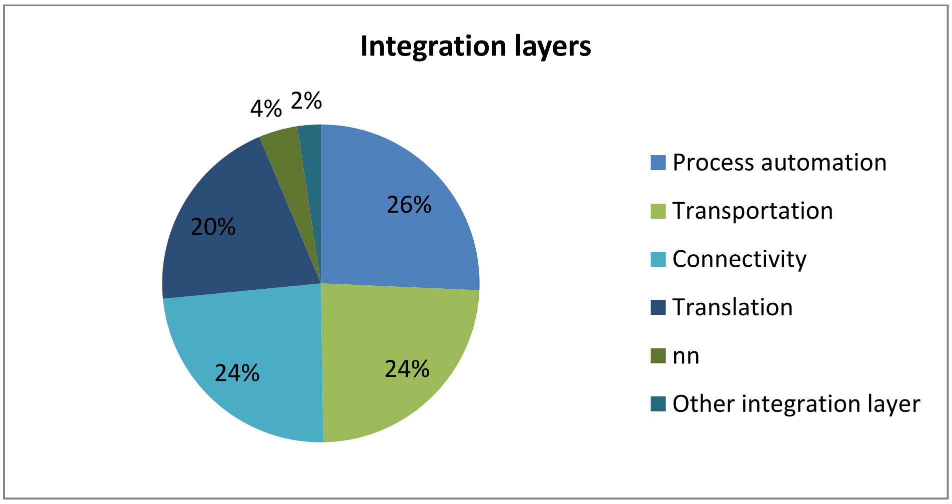

Figure 29: Integration layers

The next question was, which form of solution had been applied or was planned at the time. In all subject-areas of the participating hospitals, integrated products had been implemented. Toolkit applications were indicated as well (cf. Figure 30).

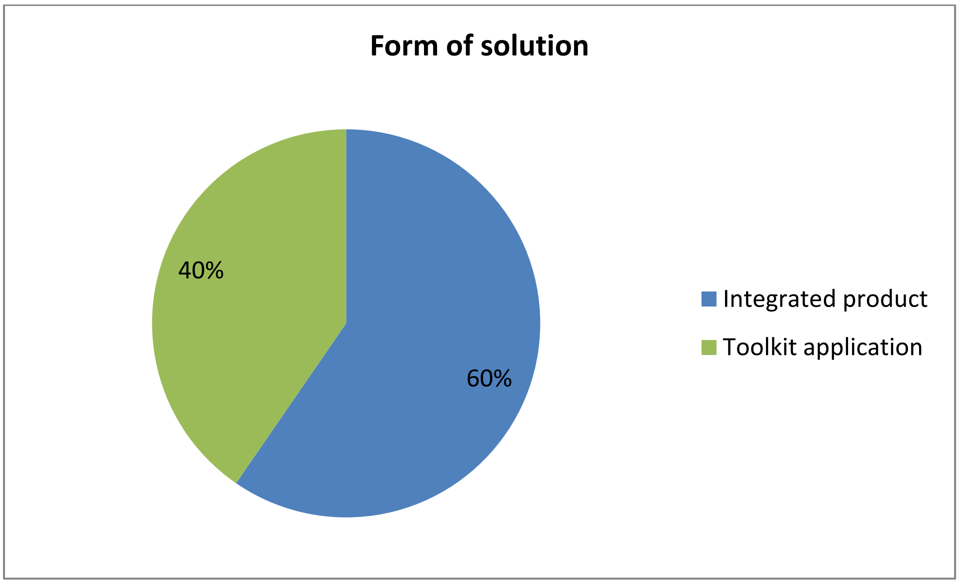

Figure 30: Form of solution

Further, it was asked which degree of integration (coupling) had been chosen or was planned at the time. Both loose and tight coupling were mentioned in the different subject-areas as displayed in Figure 31. Here again, it became clear that an individual and more detailed observation had to be applied in order to be able to reach a differentiated clarification if necessary.

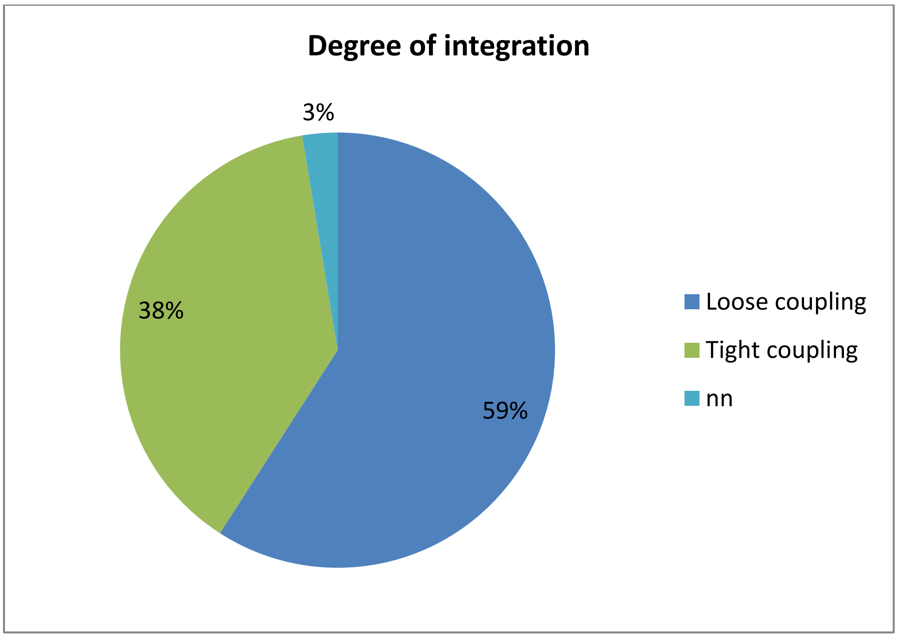

Figure 31: Degree of integration

To finish with, the question about the chosen or planned target applications in every subject-area was asked. There seems to be a tendency towards standard applications / purchased software, but also customer specific applications / in-house developments were indicated as illustrated in Figure 32.

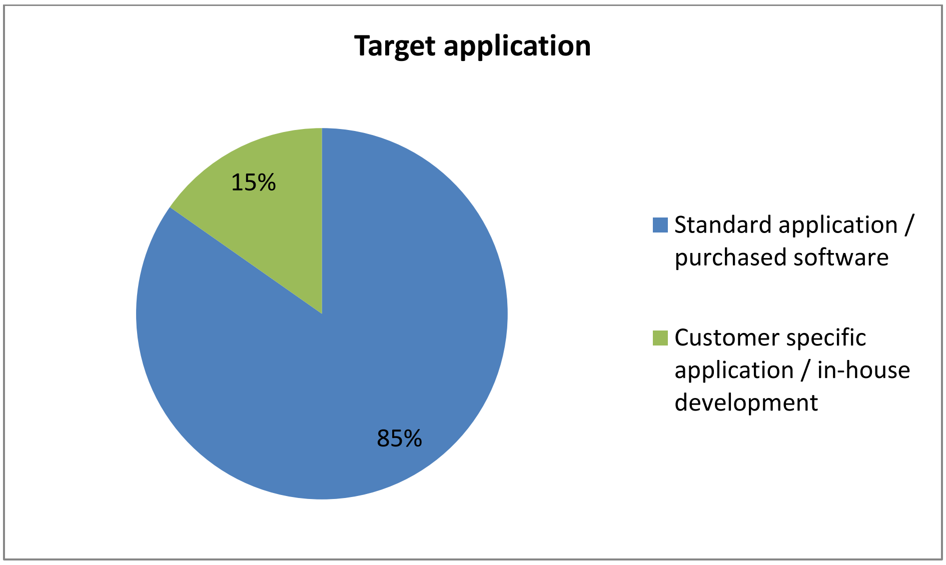

Figure 32: Target application

4.1.1.8 Reporting in the First Iteration of the “Theorising” Phase

Overall, it can be said that application alignment and integration in the non-medical support services are current topics in Swiss hospitals and therefore relevant. There seem to be no standardized specific technical procedures for application integration within the hospital context; measures applied in other industries are also used within the hospital ICT. The results show that in terms of technical procedures handling for integration of applications within the different non-medical subject-areas, a further examination is necessary, taking into account specific needs and/or general conditions as well as additional, non-technical aspects within the hospitals in order to reach generalizable results. It also became clear that further literature research was necessary.

4.1.1.9 Critical Reflection of the Quantitative Research Undertaken in the First Iteration of the “Theorising” Phase

The critical reflection is conducted based on the quality criteria framework by Gerber et al. (2018). As outlined in section 3.4, in this subsection, firstly integrity and trustworthiness and secondly the contextual rigour demonstrated in this iteration will be discussed.

4.1.1.9.1 Critical Reflection on Integrity and Trustworthiness in the First Iteration of the “Theorising” Phase

The research motivation, the goal, the context and the research design were explicitly outlined by the researcher and verified by an ethical board. By contacting the sample explaining the general context, the motivation and the aim of the research, justification of research, transparency about background and goal of the research and participant briefing can be considered as given. As the whole sample had the possibility to decide completely voluntarily about participating in the survey and as no dependency between the researcher and the sample was prevalent, as well as because it was possible for every participant to quit the survey at any time and as the participation was anonymous, risk and harm for the participant can be seen as very low.

The small sample size could indicate a reduced degree of anonymity – however, because all the asked questions were technical/institutional enquiries and as no personal or private data was asked at all, risk and harm for the participants can still be assessed as very low. The sampling strategy was revealed and explained. Using an official survey tool, data protection and legal requirements could be assured as far as possible. Due to the nature of an online survey, the safety of the researcher in this context can also be assessed as given. Due to the manageable scope of the survey and the generated data, ensuring accuracy of data analysis can be assessed as not being a very complex issue. Due to the fact that all data was collected anonymously, confidentiality could be assured throughout the whole analysis phase. As only the researcher was involved in this digitally conducted analysis, her safety could be ensured in this context. Participants who had explicitly expressed their interest were provided with the illustration of the analysed results. The research design was deliberately set up in a method pluralistic manner; this first quantitative iteration was deliberately declared as a first starting step investigating the relevance of the research question. Member checks were therefore not applied as the following iterations can be seen as an attempt for a deeper understanding and further development of the context. The results were used for setting up the interview guideline of the next iteration; a further dissemination of the results was not undertaken, discussions of impacts for stakeholders were therefore not conducted.

4.1.1.9.2 Critical Reflection on Contextual Rigour in the First Iteration of the "Theorising" Phase

The sampling strategy and participation of this iteration can be summarised as shown in Table 15.

Table 15: Summary of sampling strategy and participation in the first iteration of the "Theorising" phase

Method	Population	Sampling	Effective sample size	Hospital profile	Participant profile/Function
Online survey (quan)	22 members of Swiss SAP Usergroup in Hospitals (SSAGK)	non-probability, purposive, heterogeneous, high intensity sampling by people (ICT staff and managers as experts, representing their specific professionalization)	6 partici-pants	n / a	ICT specialists qualified to represent their employer in Swiss SAP Usergroup in Hospitals (SSAGK)

The contextual rigour of the initial quantitative data collection has to be put in its context: The goal was to investigate the relevance of the research question and to gain access to the target population of the subsequent research. Under these circumstances, the small population and the even smaller number of participants can be accepted as sufficient, particularly also because the sensitising of the target population took place and several experts responded to be available as experts for the further steps. The operationalization was deductively set up based on literature. By discussing and pre-testing with experts of the field, the quality of the questionnaire was sought to be enhanced. Applying an official, functioning survey tool, the quality of the conduct of the survey could also be ensured.

The independence of the researcher from the research results was actively searched and by setting up and analysing the survey based on literature explained in subsection 4.1.1.3, objectivity of application, analysis and interpretation according to Lamnek (1995), Mayer (2009), Ramb and Wübbenhorst (n.d.) and Steinke (1999) can be estimated as given. Due to the chosen sample and the small response size, reduced reliability according to Maier and Wübbenhorst (n.d.), Mayer (2009), Pervan and Klass (1992), Saunders et al. (2016), Sreejesh et al. (2014) and Steinke (1999) has to be assessed. Inter-coder reliability according to Mayring (2010) was sought by discussing the manageable number of results with another researcher. As the assessment of the intended measurements can be judged as technically oriented, straightforward and physically controllable, content validity according to Sreejesh et al (2014) and Wübbenhorst (n.d.) and ecological validity according to Braun and Clarke (2013) and Mayer (2010) can thus be assessed as given. Basing the criteria on underlying theory, construct validity according to Lamnek (1995), Mayring (2010), Sreejesh et al (2014), Steinke (1999) and Wilson (2014) was also ensured. However, due to the small sample, the external or population validity according to Braun and Clarke (2013), Steinke (1999), Wilson (2014) and Wübbenhorst (n.d.) was not reached.

4.1.1.10 Chapter Summary of the First Iteration of the "Theorising" Phase

The quantitative survey in the first iteration of the "Theorising" phase was conducted in order to understand the environment better and to become more aware of the problem about the current situation of non-medical support software applications in hospitals, as well as to sensitise the target population in order to gain access to experts for the following research steps. In an online survey, questions about conducted or planned integration styles, layers of integration, form of the solution, degree of integration and chosen target applications in the context of non-medical support services in hospitals were asked.

The summarised conclusions of this iteration are:

- Even though a small population was targeted and only a limited number of hospital ICT experts participated, it became clear that application alignment and integration in the non-medical support services in hospital are current topics, they are however handled with differing technological methodologies.
- The survey showed that to gain deeper awareness of the problem aspects and the overall context in order to understand the requirements and to set the scope of research, further literature research and qualitative expert interviews were necessary.
- The quantitative survey proved to be suitable to provide a basis for the initiation of qualitative interviews as well as for recruiting experts, however it did not provide reliable, valid statistical results.

In Figure 33, the quantitative research conducted in the first iteration of the "Theorising" phase is shown within the overall research design.

Research Design – First Iteration of Theorising Phase (based on Gerber et al., 2018, p. 7)

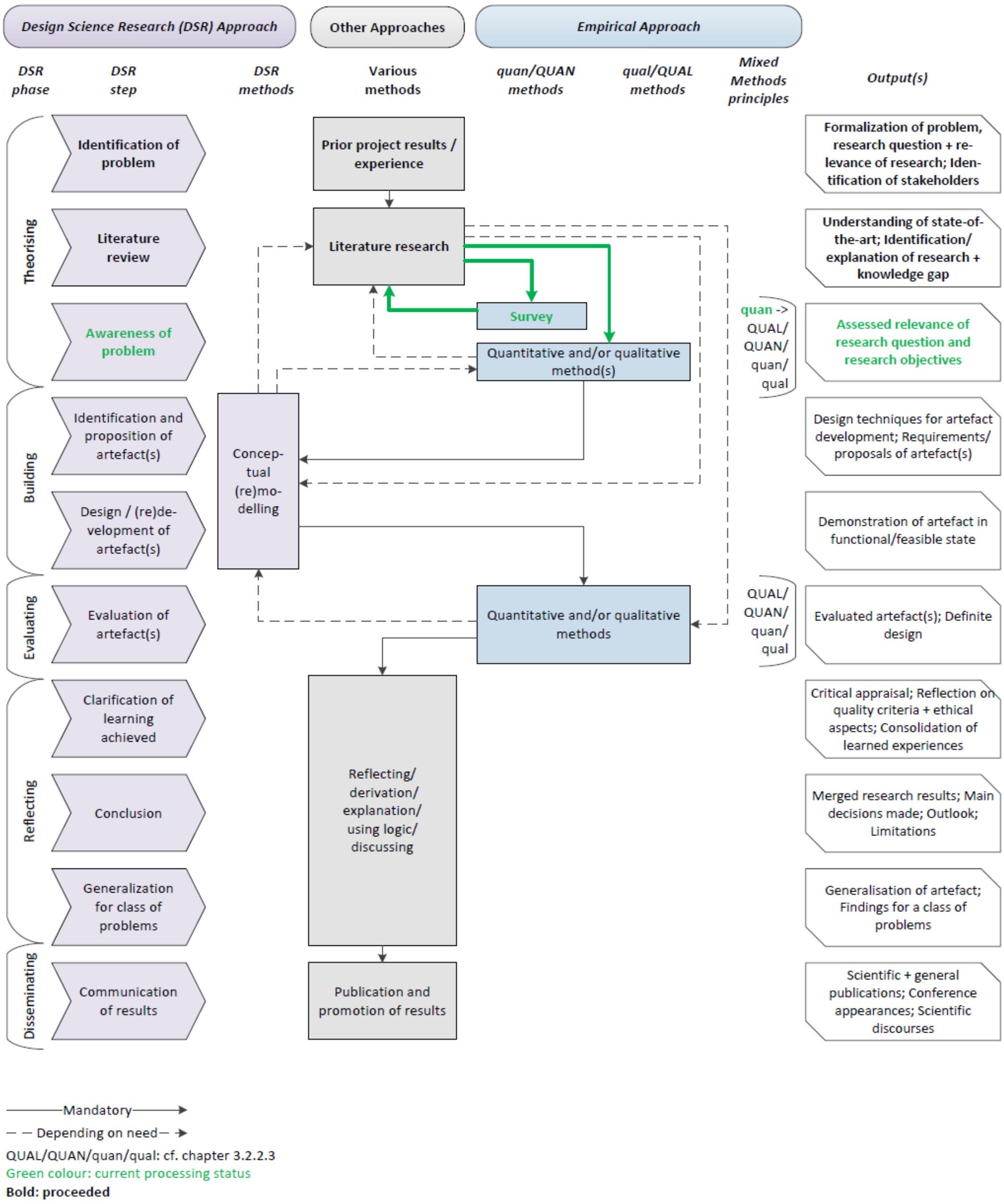

Figure 33: Illustration of the quantitative research in the first iteration of the “Theorising” phase within the overall research design

4.1.2 Research Conducted in the Second Iteration of the “Theorising” Phase

Based on the findings of the quantitative survey of the first iteration of the “Theorising” phase (cf. subsection 4.1.1), the goal of the next iteration was to collect information about the internal and external environment of the field under investigation – the hospital ICT managers dealing with non-medical support service software applications – in order to firstly thoroughly understand the problem and secondly to investigate the necessary aspects to integrate in the model. For that purpose, problem-centred, theory generating, semi-structured, face-to-face expert interviews according to Easterby-Smith (2012), Flick (2016), Lamnek (2010), Mayer (2009), Mayring (2016), Meuser and Nagel (2009), Saunders (2016) and Wilson (2014) and thus a qualitative approach was chosen.

The different steps of qualitative data collection and analysis within the “Theorising” were conducted following the steps “sampling”, “sensitising concept”, “interview guideline”, “pre-test”, “conducting interviews”, “analysis” and “reporting” proposed by Mayer (2009, p. 42), complemented with the steps “transcribing” and “critical reflection” as illustrated in Figure 34.

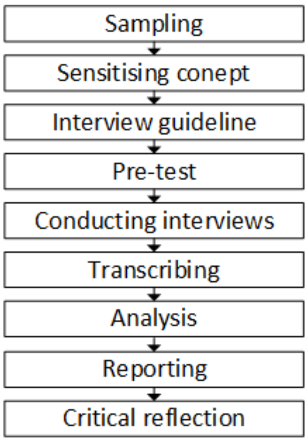

Figure 34: Research conducted in the second iteration of the “Theorising” phase according to Mayer (2009, p. 42, translated by the author)

The steps will be discussed in detail in the following subsections.

4.1.2.1 Target Population and Sampling in the Second Iteration of the “Theorising” Phase

As stated above, the goal of the second iteration of the “Theorising” phase was to obtain the data necessary to develop a procedure reference model supporting the alignment and integration of non-medical applications in Swiss hospitals and thus to reach the research aims and objectives. As indicated in subsection 2.1.2.5.2, the population of all hospitals in Switzerland was, according to the Swiss Federal Statistical Office (BFS Bundesamt für Statistik, n.d.), 283 entities in 2016. This number includes hospitals in German, French, Italian and Roman speaking areas of Switzerland. In order to avoid language barriers and a dilution of significance in the generated data collection, the hospitals in non-German-speaking areas were excluded from the population, leading to a target population of 216 hospitals in the German-speaking area of Switzerland.

In order to be able to develop a procedure reference model representing the hospital industry and thus having a high potential for generalization according to Flick (2016), a non-probability, purposive heterogeneous population approach according to Saunders et al. (2016) was chosen. The aim was to include as many hospital categories defined by the Swiss Federal Office of Public Health (BAG Bundesamt für Gesundheit, 2018) as possible in the sample for the research conducted in this iteration to reflect the complexity of the industry (Flick, 2016). As the goal was to obtain the necessary information and estimates about the current and possible future procedures for aligning and integrating non-medical support service applications in hospitals, it was decided to sample by people according to Boyatzis (1998), sampling ICT staff/managers concerned with non-medical applications and/or hospital ICT architecture, representing their specific professionalization according to Flick (2016).

4.1.2.2 Sensitising Concept in the Second Iteration of the "Theorising" Phase

As a basis for the interview guideline, findings about factors affecting the enterprise application integration adoption in the healthcare sector, the lessons learned and the stakeholders in this context investigated by Khoumbati et al. (2006), Khoumbati and Themistocleous (2008), Mantzana and Themistocleous (2004), Mantzana and Themistocleous (2005), Mantzana and Themistocleous (2006), Mantzana et al. (2008) (cf. subsections 2.3.4.3.2 and 2.5.3) were chosen. The goal was to build upon their findings, however particularly investigating non-medical application alignment and integration, which had not been done yet.

The following six aspects about classification of a hospital and its ICT identified by Khoumbati and Themistocleous (2006), Khoumbati and Themistocleous (2008), Mantzana and Themistocleous (2004), Mantzana and Themistocleous (2005), Mantzana and Themistocleous (2006) and Mantzana et al. (2008) were used as an introductory part of the interview, firstly to have a general starting point into the interview and secondly to possibly obtain information about the need for differentiation of certain aspects in the procedure reference model:

- ICT infrastructure
- Compatibility
- Organisation size
- Organisational readiness
- Evaluation frameworks of integration technologies
- Education

To set up a systematic interview guideline, it was divided into the 6 views of the widely used PESTLE framework (PESTLE Analysis, n.d.):

- Political view
- Economic view
- Social view
- Technological view
- Legal view
- Ecological view

By asking in every one of those six views about

- internal or external pressures
- advantages or chances
- disadvantages or risks

the important aspects identified by Khoumbati and Themistocleous (2006), Khoumbati et al. (2006), Khoumbati and Themistocleous (2008), Mantzana and Themistocleous (2004), Mantzana and Themistocleous (2005) and Mantzana and Themistocleous (2006) (cf. subsection 2.3.4.3.2) could be included.

The involvement of the stakeholders identified by Mantzana and Themistocleous (2005) (cf. subsection 2.5.3) was added as a specific sub-question under the social view, cost pressure as a specific sub-question under the economic view and data protection / data governance as a specific sub-question under the legal view.

Within the technological view, the already developed general procedure model for application integration by Schwinn (2005) summarised in the first part of Appendix 4 and illustrated in Appendix 5 was involved in order to get indications from the experts, if such a procedure approach could be used or what should be adapted for the specific situation in hospitals.

The aspects of telemedicine and patient satisfaction also being mentioned as important aspects in the frameworks of Khoumbati et al. (2006), Mantzana and Themistocleous (2005), Mantzana and Themistocleous (2006) and Mantzana et al. (2008), were not included in the guideline due to the fact that the scope of the thesis was the non-medical support applications, explicitly not including medical topics.

4.1.2.3 Interview Guideline in the Second Iteration of the “Theorising” Phase

Based on the principles of the sensitising concept explained in the previous subsection, a semi-structured interview guideline was set up. In terms of question types, theory-driven questions based on literature and open questions were applied in a deductive-inductive hybrid approach according to Flick (2016). The guideline is displayed in a compact manner in Appendix 4.

4.1.2.4 Pre-test in the Second Iteration of the “Theorising” Phase

The interview guideline was pre-tested in two ways: Firstly, the understandability of the questions and the logic of the setup were tested with two independent researchers. Secondly, the guideline was discussed with an expert in ICT in healthcare who did not take part in the interview.

4.1.2.5 Conducting Interviews in the Second Iteration of the “Theorising” Phase

According to Easterby-Smith et al. (2012), the following five aspects are important to consider when conducting interviews:

- Obtaining trust
- Social interaction
- Using the appropriate language
- The location of the interview
- Recording interviews

Obtaining trust was the aim already in the phase of contacting the experts personally, providing background information about the researcher and clearly and transparently communicating the goal of the research and the foreseen length of the interview. A punctual appearance, small talk to start with and presenting the information about the participant rights displayed in the consent form were further measures, not only for obtaining trust, but also to have social interaction. Unclear technical or ICT terms used in the interviews were not detected, the context of non-medical support services had sometimes to be clarified which was supported by a printout of an illustration of the scope. The interviews were conducted in meeting rooms provided by the experts in their working environment. The interviews were recorded by taking notes by the interviewer on the specifically prepared printout as the goal was to get main indications and categories for the model to be developed. The notes turned out to be helpful to get back to previously given answers together with the interviewees in order to specify when necessary.

4.1.2.6 Transcribing in the Second Iteration of the "Theorising" Phase

The following transcription procedure based on Kuckartz (2010, p. 52) was chosen:

- Choice of transcription type
- Definition of transcription rules
- Proofreading of transcripts and ensuring anonymization

As para-verbal inputs (breaks between words, voice intonations etc.) according to Dresing et al. (2015), Kowal and O'Connell (2015) and Kuckartz (2010) were not the focus of the analysis at all but much rather a fast access to the content concerning the construction of a model according to Dresing et al. (2015), a protocol-based, summarising transcript type according to Kuckartz (2010) and Mayring (2016) was electronically captured based on the written records to enable the import in a digital analysis tool.

As only the author was involved in the transcription as well as the translation and as no para-verbal context had to be registered, the transcript rules according to Dresing et al. (2015), Kuckartz (2010) and Ludwig-Mayerhofer (1999) could be kept short and were defined as follows:

- The question posed by the interviewer was copied from the interview guideline and marked in bold, prefixed with an "NG" as abbreviation of the interviewer's name.
- The answers from the interviewees were registered subsequently.
- Between the answer and the next question, an empty line was introduced.
- While proofreading the transcripts, anonymization and a correct translation into English was checked.

Appendix 6 shows an examplary extract of an anonymized qualitative interview transcript from the "Theorising" phase.

During this procedure, a deeper understanding of what was said and a familiarization with the data according to Wilson (2014) took place preparing for the further proceeding.

4.1.2.7 Data Analysis in the Second Iteration of the "Theorising" Phase

To develop the model, the reduction of the complexity of the collected data according to Flick (2016) was the main goal of this iteration. As the guideline had been set up in an a priori research-driven approach (cf. subsection 4.1.2.3), the coding also started with an a priori, research-driven thematic code development, according to Bernard et al. (2017), Boyatzis (1998) and Kuckartz (2018), however developing the category system and data classification in an iterative manner and thus extending the initial system in a deductive-inductive hybrid approach according to Bernard et al. (2017), Boyatzis (1998) and Flick (2016). For the content structuring, the classification approach of content structuring within qualitative context analysis according to Mayring (2010) was chosen, illustrated in Figure 35 and explained thereafter.

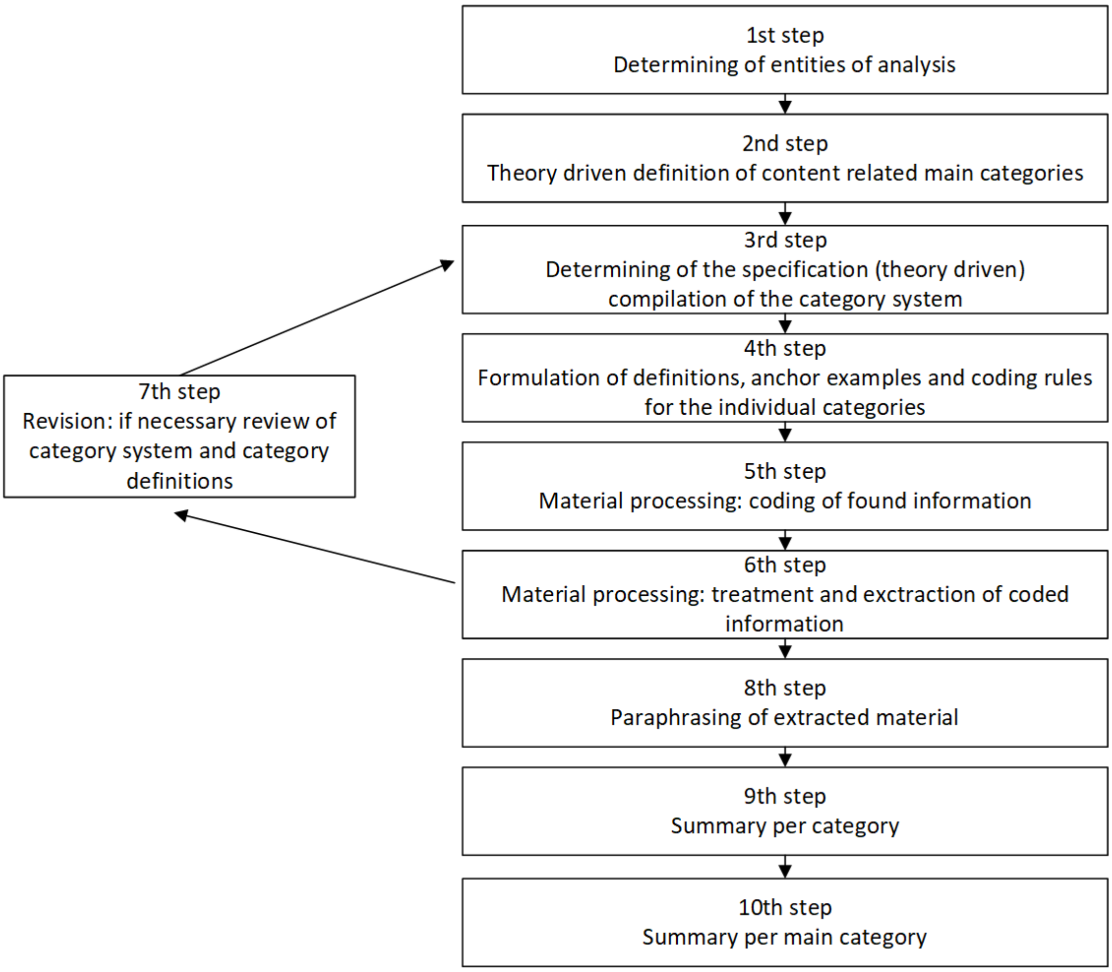

Figure 35: Process model of content structuring according to Mayring, 2008 pp. 84 & 89 (translated by the author)

The different steps displayed in Figure 35 included the following specific activities throughout the content structuring of this iteration:

1st step – Determining of entities of analysis:
All the 12 conducted interview transcripts (cf. sample in subsection 4.1.2.1) were chosen for the analysis.

2nd step – Theory-driven definition of content-related main categories and 3rd step – Determining of the specification (theory-driven) compilation of the category system:
Due to the fact that the interview guideline was already set up according to a theory-driven categorization (cf. subsection 4.1.2.2) and according to the relevant dimensions of comparison by Kelle and Kluge (2010, p. 91 et seq.), steps 2 and 3 could be merged as follows:

- Political aspects: internal pressures
- Political aspects: external pressures
- Political aspects: advantages or chances
- Political aspects: disadvantages or risks

and so forth for all PESTLE-categories (Economic aspects, Social aspects, Technological aspects, Legal aspects, Ecological aspects, cf. subsection 4.1.2.2).

4th step – Formulation of definitions, anchor examples and coding rules for the individual categories:

Step 4 could be treated in a reduced manner focusing on the content and not on the coordination between different coders, as the entire coding was done by the author.

5th step – Material processing: coding of found information:
The coding itself was conducted with the help of the coding and analysis software MAXQDA. Examples of the conducted coding are displayed in Appendix 7.

6th step – Material processing: treatment and extraction of coded information:
After the first round of material processing, it became clear that a differentiation between the internal and the external view had to be made and that in the internal context, the categories had to be named specifically for this context. In addition, the suggestions for reporting and application integration revealed that a differentiation between reporting style, degree of aggregation and degree of application integration was necessary. These findings led to a revision step.

7th step – Revision: if necessary review of category system and category definitions:
This step illustrates the process of combining theoretical and empirical clustering defined by Boyatzis (1998) and the creation of types according to Kelle and Kluge (2010).

The revision of the coding included, in terms of technical measures for providing non-medical KPIs, the following inductively generated categories:

- Reporting style
- Degree of aggregation
- Degree of integration

Regarding the external context, the ecological category from PESTLE (cf. subsection 4.1.2.2) was dropped as this aspect was not mentioned as relevant in this context by any of the experts. For the internal context, the following inductively generated categories were added:

- Finances
- Management
- Operations / business practices
- Hospital culture
- Healthcare IT

The related deductively generated main categories were inductively changed or specified as follows:

- “Pressures” to “Assessed pressures/triggers”
- “Disadvantages/Risks” to “Expected risks/challenges”
- “Advantages/Chances” to “Expected benefits”

In addition, the main category “Proposed measures” was inductively derived and introduced.

For clustering the stakeholders, a distinction between the internal and the external context was made. For the internal context, the following categories proposed by Gerber (2016, p. 6) (cf. Figure 3) were chosen in terms of the main category “Service Levels”:

- Strategic management services
- Management support services
- Non-medical support services
- Medical support services

- Medical core services

In addition, an overarching category “Hospital overall” was introduced. This distinction was accompanied by the completion of the explicit naming of the corresponding stakeholders.

In the external context, the following main categories and categories were inductively generated:

- IT: Software provider(s), consultants
- Ownership: Privately owned, government owned, foundation owned

The corresponding material processing is displayed in Appendix 8.

8th step – Paraphrasing of extracted material:
The paraphrasing of the data was done with the goal of modelling in mind, thus in note form instead of fully formulated sentences.

9th step – Summary per category and 10th step – Summary per main category
In the end, the categories and main categories for

- suggested reporting styles, data aggregation and data integration
- assessed pressures/triggers, suggested measures, expected risks/challenges and benefits and
- stakeholder clusters

were individually summarised in tabular form. It turned out that “category” and “main category” as suggested by Mayring (2010) were not appropriate dimensions for all the interim results within the multi-dimensionality of the research context. The two steps were therefore combined according to Kelle and Kluge (2010, p. 91 et seq.) and, when necessary, the categorizing labels were adjusted depending on the need. Top priority of the summarising and category definition were the actually in reality existing category types according to Kluge (1999). Appendix 7 shows the applied codes for the data analysis in the second iteration of the “Theorising” phase.

4.1.2.8 Reporting and Interpretation of the Findings of the Second Iteration of the “Theorising” Phase

As the qualitative research conducted in the “Theorising” phase was not conducted to write a (final) report, but as the basis for the modelling, reporting was done formulating the findings as a basis for this next step.

Relating to assessing integration and maturity of their hospitals, an overall assessment was very difficult for the interviewed experts. A relation between the answers and the integration and/or maturity level was not possible based on the answers given. However, the estimations of the experts were generally speaking somewhere in the middle. It was often stated that the situation of both integration and maturity had been improved lately or was currently being improved but it was also often mentioned that there was still (a lot of) room for improvement. It seems that the moment to initiate the topic of automated data reporting, data aggregation and application integration is opportune. Not only seems the importance of the topic to be clear to most experts but the Swiss hospital ICT in general just seems to develop the necessary maturity and readiness to take the next development step(s).

Specifically asked about proposed automated provisions of KPIs for non-medical support services, no uniform solution, much more very different reporting styles and data-processing methods and combinations amongst each other were proposed and mentioned by the experts as shown in Appendix 8.

This indicates that a procedure reference model has to provide the possibility to assess and deal with every non-medical subject-area individually, scrutinizing the needs and the existing reports of the operational level as well as the technical possibilities of the applied applications allowing every hospital to add to the existing solutions and prerequisites. Business Intelligence was clearly seen as a need for a higher predictability of actions. It was however mostly mentioned that the current management and the prevalent hospital culture was not, or hardly, ready for this advanced feature. This supports the estimation that the model to be developed has to be able to be implemented for different maturity levels of not only Healthcare ICT departments, but the hospital managements or the overall hospital cultures.

Regarding application alignment and integration, the necessity of a reduction of the number of applications and thus the need for application integration within the non-medical applications was emphasized by most experts. Again, it became clear that the degree and type of application alignment and integration has to be clarified for every non-medical subject-area individually, depending on the prevalent situation. For the alignment and integration procedure, the technical measures presented by Schwinn (2005) (cf. Appendices 4 + 5) were generally found to be fit also for the hospital context. However the model should be simplified for the manageability and acceptance within the assessed rather low maturity level of hospitals and it should include the idea of iterations and documentation as well as some specific healthcare aspects. The consolidated answers concerning the actions, the outputs as well as the remarks about the importance for the healthcare context are summarised in Appendix 8.

The analysis of the assessed pressures/triggers, suggested measures, expected risks/challenges and benefits for both the external political, economic, social, technological, legal, ecological view and the internal views of finances, management, operations/business practices, hospital culture and healthcare IT of application integration and alignment led to the tabular summary shown in Appendix 8.

In terms of the internal and external context, it became clear that the external aspects within the complex and mainly politically driven healthcare context can hardly be influenced by aligning the non-medical software applications. While it seems important knowing what is happening and being aware of it and ready for steps to be taken if necessary, an active external influence – apart from the cooperation with software providers and consultants – seems hardly possible within the context. One finding therefore is that the focus must be be put much more on the internal, influenceable context, specifically on the internal stakeholder involvement. Looking at the internal context, the increasing cost pressure seems to increase the necessity of software application integration and alignment, particularly in the context of KPI configuration because the increasing cost awareness seems to lead to an augmented demand for (digital) KPI reporting as a basis for reaching more efficiency. According to the interviewed experts, the proposed internal measures should have a favourable cost-benefit relationship, should consider clear and standardised definitions, should be user friendly, should include adequate stakeholder involvement and should contribute to more appreciation for ICT. However, according to the interviewed experts, there seem to be numerous expected challenges to be taken into account: On one hand, ICT in hospitals is complex, on the other hand ICT maturity and ICT affinity are considered to be (rather) low. The development of ICT in hospitals in the past as described in subsection 2.3.2.1 still seems to have a big influence on the daily business of hospital ICT managers and once again, stakeholder management turned out to be a major challenge in this context. As expected benefits, the interviewed experts mainly saw more transparency, better manageability, more efficiency and therefore cost reduction and more cooperation with other stakeholders.

The assessment of the stakeholders to be considered/involved in the integration or alignment of non-medical support service applications revealed that, depending on the context, an encompassing list has to be considered as the summarised stakeholders in Appendix 8 show.

4.1.2.9 Critical Reflection of the Qualitative Research Undertaken in the Second Iteration of the "Theorising" Phase

The critical reflection is conducted based on the quality criteria framework by Gerber et al. (2018). As outlined in section 3.4, in this subsection, firstly integrity and trustworthiness and secondly the contextual rigour demonstrated in this iteration will be discussed.

4.1.2.9.1 Critical Reflection on Integrity and Trustworthiness in the First Iteration of the "Theorising" Phase

The research motivation, goal, context and the research design were explicitly outlined and verified by an ethical board. Due to the context of the research question, no personally sensitive or privately critical questions were asked. All the experts were adults with the possibility to decide personally and consciously about the intensity of their interview participation (informed consent). To enable them to decide about their participation, they were provided with background information about the research context and goal and the researcher's motivation. There was no monetary or power dependency between the researcher and the interviewees at any time. The risk for conducting the interviews can be judged as very low and safety for all involved people during the interview was given as far as safety can be guaranteed. The interviewees were nevertheless again informed that all the data would be anonymized and that it was their right to abort the interview at any time or to withdraw their statements. Throughout the interview, a respectful, professional conduct was maintained. After the interview, the interviewees could state if they were interested in being informed about the further development, which all interviewees did. During the data analysis done digitally by one researcher, the safety aspect in the research context was not a particular concern and could be ensured at any time. As the data was already anonymized in the transcription, confidentiality and anonymity was given. By processing the analysis on a secured and backed up university computer, data protection could be ensured as far as possible. The research design was deliberately set up in a method pluralistic manner; this second iteration was consciously declared as the basis for the building phase, a further dissemination of the results was not undertaken, discussions of impacts for stakeholders were therefore not conducted. Member checks were also not applied as the following iterations can be seen as a form of participant feedback, further developing of the context.

4.1.2.9.2 Critical Reflection on Contextual Rigour in the First Iteration of the "Theorising" Phase

The sampling strategy and participation of this iteration can be summarised as shown in Table 16.

Table 16: Summary of sampling strategy and participation in the second iteration of the "Theorising" phase

Method	**Popu-lation**	**Sampling**	**Effective sample size**	**Hospital profile**	**Partici-pant profile/ Function**
Semi-structured expert interviews (QUAL)	216 hospi-tals	non-probability, purposive heterogeneous sampling by people (hospital ICT staff/managers concerned with non-medical applications and/or hospital ICT architecture)	Total of 12 experts		
			2	General hospitals, Centrum care (Level 1, University Hospitals)	ICT
			6	General hospitals, Centrum care (Level 2)	ICT
			1	Psychiatric clinics (Level 1)	ICT
			3	Rehabilitation clinics and Special clinics (Surgery, Gynae-cology/Neonatology, Paediatrics, Geriatrics, Diverse)	ICT

When testing the quality of the sampling according to Boyatzis (1998), the sufficient variety of units of analysis can be classified as given: The number of interviewed experts is in the suggested range of 12 – 30 within a heterogeneous population according to Saunders et al. (2016, p. 297), even more when considering that they represented more than 30 hospital (sub-)entities, including all the different categories of centrum care, primary care, psychiatric clinics and rehab/special clinics. In addition, throughout the conduct of interviewing, a certain saturation of the answers according to Kelle and Kluge (2010) could be recognized, also indicating that the size of the sample was adequate. The experts as representatives of their field of action – management of non-medical support service applications in hospitals – according to Flick (2016) turned out to be a good start for the research context.

The pre-testing of the interview guideline with several experts in the field not involved in the interview process itself was a specific measure to enhance the quality of the interview guideline and to ensure a context-correct language. The fact that the researcher as interviewer already had theoretical and practical experience with interviewing experts and managers, as well as expertise in the field, an important requirement to capture complex context in reduced time according to Flick (2016), Lamnek (2010), Liebold and Trinczek (2009), Trinczek (2009) and Wroblewski and Leitner (2009) was given. At the same time, the peculiar situation of expert roles for both the interviewer and the interviewee discussed by Liebold and Trinczek (2009) and Obelené (2009) and the thus necessary balancing act between openness in order to capture different aspects and structuring with regard to scope and future analysis had to be taken into consideration. The interview guideline was therefore the basis for orientation throughout the interviews. In addition, a mix of open and semi-structured questions was used in order to reduce the risk of influencing according to Flick (2016). The risk of conscious deception or mixing the roles of expert and private person discussed by Meuser and Nagel (2009) was rather low because no personally sensitive or privately critical questions were asked and even more as the interviews were not tape recorded (Flick, 2016).

According to Brinkmann and Kvale (2015), Dresing et al. (2015), Easterby-Smith et al. (2012), Kuckartz (2010), Moustakas (1990) and Wilson (2014), the interviewer has to decide on different aspects of data collection in the specific context balancing confidentiality, comfort and thus trust, the goal of data generation and also the effort-benefit-relationship. As the goal of the interviews in the "Theorising" phase was to obtain information with regard to developing a model, a word-for-word transcription was found an inappropriate basis even more as by translating the German answers of the experts into English for the documentation of the thesis, a heuristic reduction of the answers and a smoothing of the interviews by translating according to Kuckartz (2010) and Mayring (2016) occurred. This circumstance potentially influenced the quality of the data collection.

As the interviews were completely coded and analysed by one researcher, divergence of data handling was, on one hand, minimized according to Lamnek (1995) and Mayer (2009). On the other hand, inter-coder reliability according to Mayring (2010) and Kuckartz (2010) could not be assured. In order to have a research pragmatic number of groups according to Lamnek (2010) and Kluge (1999), a reduction and simplification of dimensions had to be applied. This happened with the awareness that with a reduction, important information could be lost. To minimize this impact, Kluge’s (1999) suggestion to consider the empirical distribution and to focus on the research goal was deliberately kept in mind. Regarding the applied deductive-inductive creation of categories, Kelle and Kluge (2010) emphasize that an iterative integration of empirical and theoretical steps make a good qualitative research and the creation of types in a theoretical and empirical combination is declared as particularly suitable to reach this goal. The fact that the expert interviews were only one part in the multi-method research approach, disadvantages of the applied method could potentially be compensated by methods in the following research steps as proposed by Flick (2016) and Bogner and Menz (2005).

Assessing the overall qualitative quality criteria adequate for this phase, the intersubjective transparency and indication according to Boyatzis (1998), Flick (2007), McLeod (2011), Saunders et al. (2016), Steinke (1999) and Yardly (2015) can be assessed as given, due to the particularly detailed documentation of personal anticipations, the involvement of the researcher, the data and information sources, the decisions and challenges, the appropriateness of the method choice and the choice of sample as well as the indication of the limitations and underlying understanding. With the explicit documentation, explanation and reasoning of the conducted research steps and procedures, the intersubjective transparency and indication according to McLeod (2011), Steinke (1999), Saunders et al. (2016) and Yardly (2015) as quality criteria for the qualitative research was ensured. The methods to collect and analyse the data can be assessed as pragmatic and adequate to the context and the findings generated in this qualitative research in the “Theorising” phase can be declared as empirically anchored according to Steinke (1999) and thus fit as a basis for the “Building” phase. Nevertheless, it must be emphasized that they were interim results, lacking evaluation and validation at this stage.

4.1.2.10 Chapter Summary of the Second Iteration of the “Theorising” Phase

The goal of the second iteration of the “Theorising” phase was to collect information about the internal and external environment of the hospital ICT dealing with non-medical support service software applications to thoroughly understand the problem and to investigate the necessary aspects to integrate in the model.

Methodologically, twelve problem-centred, theory generating, semi-structured, face-to-face expert interviews with hospital ICT staff/managers concerned with non-medical applications/ICT architecture recruited in a non-probability, purposive heterogeneous sampling approach were conducted. The recorded interviews were transcribed, coded and categorized and the findings reported and interpreted.

The summarised conclusions of this iteration are:

- The model has to provide the possibility to assess and deal with every non-medical support subject-area individually.
- The model has to allow adaptations, depending on the maturity levels of ICT and/or hospital management and/or overall hospital culture.

- The model has to clearly focus on stakeholder management and stakeholder involvement rather than technical aspects.
- The model should encompass a vast list of potential stakeholders to be considered.
- The model should have a favourable cost-benefit relationship and should be well understandable in order to ensure manageability and acceptance.
- The model should include the idea of iterations.
- The model should explicitly include the aspect of documentation.
- The procedure should involve an assessment of the needs and the existing reports for KPIs, an analysis of the existing application context and a specification of the technical needs in order to implement the found solution.
- The timing to introduce a model in the presented context seems to be favourable.

The results provided the basis for the conceptual modelling, however also showed the need for more literature reviews in specific topics, e. g. stakeholder management (in healthcare).

In Figure 36, the qualitative research conducted in the first iteration of the “Theorising” phase is shown within the overall research design.

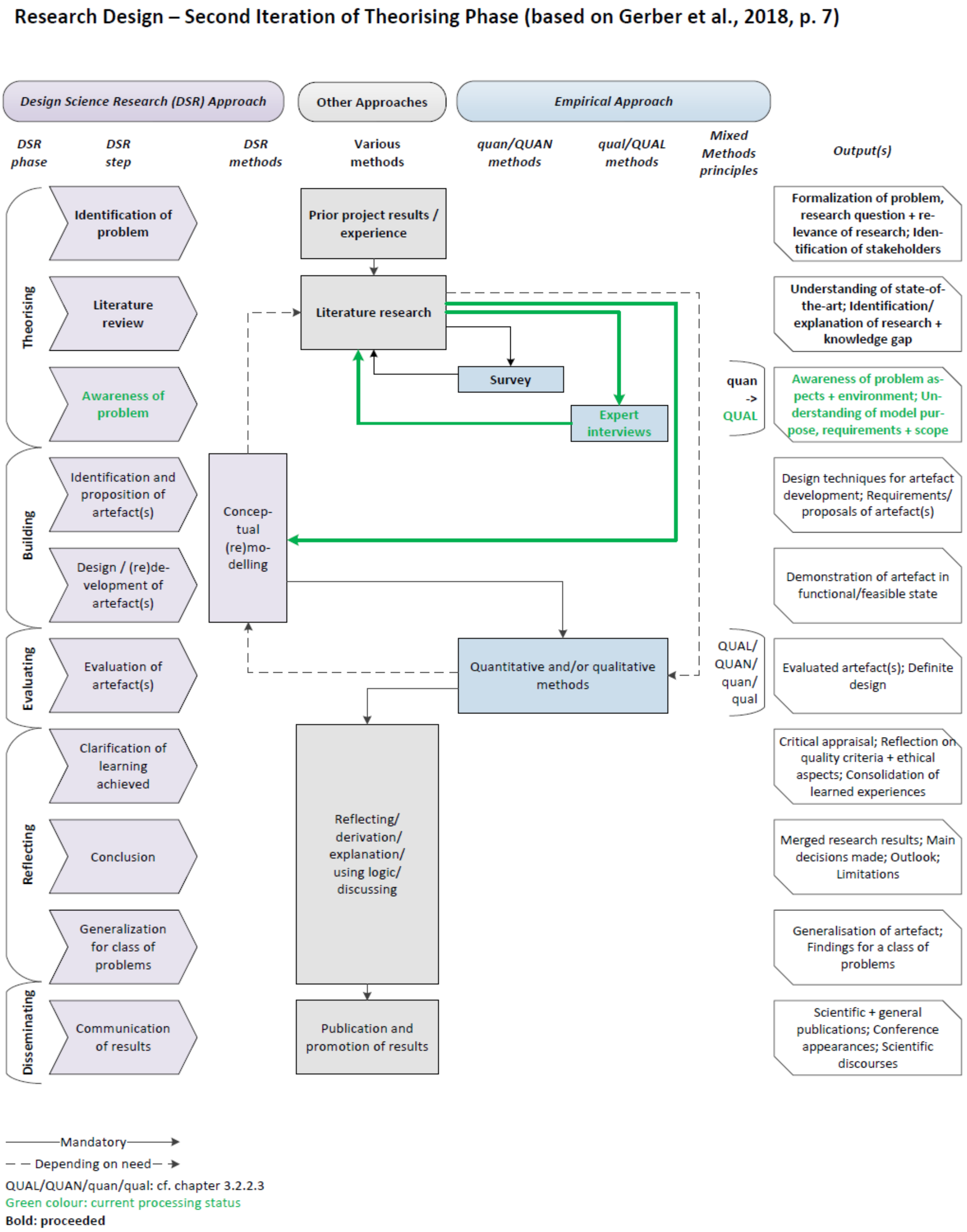

Figure 36: Illustration of the qualitative research in the second iteration of the “Theorising” phase within the overall research design

4.1.3 Summary of “Theorising” Phase

The goal of the “Theorising” phase according to Gerber et al. (2018) (cf. Figure 19) was to identify the problem, to define the scope of literature research for the existing background, theories and solutions and to gain awareness and a deeper understanding of the problem and to thereby obtain the basis for the procedure reference model to be developed according to the research aim (cf. subsection 1.3.1).

The application of a sequential exploratory mixed methods approach according to Creswell (2014) and Creswell and Plano Clark (2018) (cf. subsection 3.2.2.3) combining a quantitative survey with qualitative expert interviews as a basis for the following “Building” phase turned out to be suitable, not only showing the relevance of the research question but also delivering the necessary data for building the artefact.

4.2 Actions Conducted in the "Building" Phase

Two iterations were conducted within the "Building" phase. In this section, the general conditions and objectives of the model and the modelling for both iterations will be described followed by the descriptions of the modelling actions of both modelling iterations, a critical reflection of the actions conducted in this phase and a chapter summary.

4.2.1 General Conditions / Objectives of the Model and the Modelling

After the data collection and analysis in the "Theorising" phase (cf. section 4.1), the "Building" phase with the goal to construct a model answering the research question (cf. section 0) could be initiated. In this subsection, the different actions conducted throughout the building phase will be explained, beginning with the first building iteration, followed by the second re-design iteration. All actions undertaken in the "Building" phase were based on the pragmatic basic belief (cf. section 3.1), the design-oriented Design Science Research principles (cf. subsection 3.2.2.2 et seq.) and particularly following the soft modelling approach described by Pidd (2004) and Pidd (2009) (cf. subsection 3.2.6). The understanding of the role of the modeller throughout the (re-)building is illustrated in Figure 20.

4.2.2 Modelling Actions Conducted in the First Iteration of the "Building" Phase

In this subsection, the actions conducted in the first modelling iteration of the "Building" phase will be explained in detail, including the explanation of the relevant content to involve based on the analysis, the derivation and choice of the model types, the notations and tools, the development of the modelling structure and the modelling methods.

4.2.2.1 Relevant Content to Involve from Analysis in the First Iteration of the "Building" Phase

In terms of building the model, the analysis of the qualitative iteration in the "Theorising" phase (cf. subsection 4.1.2.7) revealed that the model has to

- offer the possibility to assess and deal with every non-medical subject-area individually
- be as simple as possible for the manageability and acceptance within the assessed rather low maturity level of hospitals
- include the idea of iterations
- ensure documentation
- allow individual adaptation dependent on the very heterogeneous current situations and landscapes

In terms of the procedure, the analysis of the data indicated that three different contexts have to be recognized and included:

- an assessment of the needs and the existing reports for KPIs within the operational level under assessment
- an analysis of the existing application context within the overall application landscape or software architecture, in order to assess the potential degree of aggregation and integration
- a specification of the technical needs in order to implement the found solution

In terms of stakeholders, the analysis of the data showed that a wide range of internal and external stakeholders have to be taken into account. Appendix 8 summarises the analysed stakeholder clusters proposed to be included in the further modelling process. The analysis also revealed that stakeholder management should be a substantial part within the model to be weighted more than the technical implementation aspects.

4.2.2.2 Derivation and Choice of Model Types in the First Iteration of the "Building" Phase

As the research aim defined a procedure reference model as the outcome, the choice of model was set. The inherent setup of a metamodel for the procedure reference model was also given as a requirement (cf. subsection 2.6.2.1). The necessity for individual adaptation of the procedure depending on the needs and the current situation of a hospital or department brought about the necessity to divide the procedure reference model into component models (cf. subsection 4.2.2.1).

4.2.2.3 Derivation and Choice of Modelling Notations in the First Iteration of the "Building" Phase

The various proposed notations for different kinds of models are explained in subsection 2.6.2. As described in subsection 4.2.2.1, a broad understanding and acceptance of the model notation by different stakeholders and the allowance of individual adaptation were aimed at. Thus, relatively easy to understand graph-based, semi-formal, standardized and widely accepted notations like Event Driven Process Chains (EPC), Unified Modelling Language (UML), Business Process Management Notation (BPMN), Entity Relationship Diagram/(modified) Chen notation (ERD or ERMN), flow chart/workflow or system diagram/system flow charts as described in subsection 2.6.3 were considered. Due to the fact that the output was to be a procedure reference model showing processes in a business context, the BPMN notation according to Allweyer (2010), BPMN Offensive Berlin (2011), Freund and Rücker (2017) and OMG (2011) was chosen for the procedure reference model and the component models (details about BPMN cf. subsection 2.6.3). As the goal of the metamodel was to show the relationships of the different elements of the procedure and component models, an Entity Relationship Modelling Notation (ERMN) according to Academic dictionaries and encyclopaedias (n.d.), Chen (1976), Chen (1981), Chen (1991) and Chen (2002) was chosen (details cf. subsection 2.6.3).

4.2.2.4 Choice of Modelling Tools in the First Iteration of the "Building" Phase

For the – in the "Theorising" phase assessed – need o model adaptability, out of the range of possible modelling tools described in subsection 2.6.3, only widely accessible and implemented tools were considered. As Microsoft Office applications are commonly implemented and used in practice and thus also in hospitals, Microsoft Visio was applied for setting up the models and Microsoft Excel for the input documents, using the integrated features of both modelling languages, ERMN and BPMN.

4.2.2.5 Modelling Methods in the First Iteration of the "Building" Phase

Out of the modelling methods mentioned in the Design Science Research Cycle for Business and Management Research in Figure 19 within the "Building" phase, applying experience, creativity, principles of form and function and using logic were consciously used.

4.2.2.6 Development of Modelling Structure / Layout in the First Iteration of the "Building" Phase

In terms of structure and layout, the aspects identified in the data analysis of the second iteration of the "Theorising" phase (cf. subsections 4.1.2.7 and 4.2.2.1) were integrated as follows:

- The content of the layout was deliberately kept as simple and reduced as possible, using intuitive symbols.
- The need for iterations was picked up in two ways: the possibility to iterate between the two iterations and between the processes of each iteration.
- The documentation was integrated via two explicit input documents.
- Stakeholders were visually placed in the centre of the model and in addition, a specific stakeholder documentation was introduced.
- The model was set up in a generic manner enabling the application for every subject-area.

As illustrated in Figure 37, integral parts of the procedure reference model turned out to be

- six component models
- two input documents
- one metamodel
- one documentation

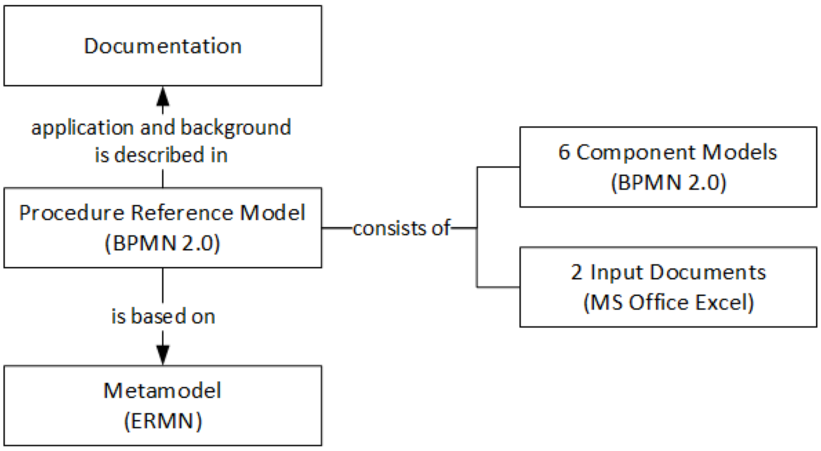

Figure 37: Illustration of Procedure Reference Model including its integral parts

The detailed description and explanation of all aspects of the model proposition in the first iteration of the "Building" phase, including the components model, the input documentation and the metamodel can be found in the documentation in Appendix 9.

4.2.2.7 Critical Reflection of the Building Actions Undertaken in the First Iteration of the "Building" Phase

The critical reflection is conducted based on the quality criteria framework by Gerber et al. (2018). As outlined in section 3.4, firstly integrity and trustworthiness and secondly the contextual rigour demonstrated in this iteration will be discussed.

4.2.2.7.1 Critical Reflection on Integrity and Trustworthiness in the First Iteration of the "Building" Phase

The research motivation, goal, context and the method pluralistic research design were explicitly outlined – also for the "Building" phase. As the modelling was done by the author and since no interaction with other people took place and no personal data was processed, all ethical aspects concerning further participants could be omitted in this iteration. During the modelling done digitally by one researcher, the safety aspect in the research context was not a particular concern and could be ensured at any time. By processing the analysis on a secured and backed up university computer, data protection could be ensured as far as possible.

4.2.2.7.2 Critical Reflection on Contextual Rigour in the First Iteration of the "Building" Phase

With the decision to apply the Design Science Research approach, the inherent corresponding quality criteria were explicitly observed, not only during the setup of the research design, but particularly during the modelling actions in the first iteration of the "Building" phase as documented in the subsections 4.2.2 et seq. This first building iteration was deliberately declared to be evaluated in a next iteration in order to assess the degree of utility, practicability and viability.

4.2.2.8 Chapter Summary of the First Iteration of the "Building" Phase

The goal of the first iteration of the "Building" phase according to the Design Science Research Principles based on Gerber et al. (2018) (cf. Figure 19) was to present a tentative design of a procedure reference model according to the research aim (cf. subsection 1.3.1). Based on existing theories and propositions for building and evaluating procedure reference models and also based on the identified relevant content to involve from the analysis of the second iteration of the "Theorising" phase (cf. subsection 4.1.2.7), in a first modelling iteration, the following outputs were generated, applying experience, creativity, principles of form and function and logic as modelling methods:

- a procedure reference model including six component models constructed with the BPMN 2.0 notation using Microsoft Visio as a modelling tool
- an underlying metamodel in the Modified Chen Notation also using Microsoft Visio as a modelling tool
- two model input documents set up in Microsoft Excel
- a documentation explaining the context and the application of the model

Details can be found in Appendix 9.

The model including its integral parts could be demonstrated to the extent that a first evaluation iteration was possible.

In Figure 38, the modelling actions conducted in the first iteration of the “Building” phase are shown within the overall research design.

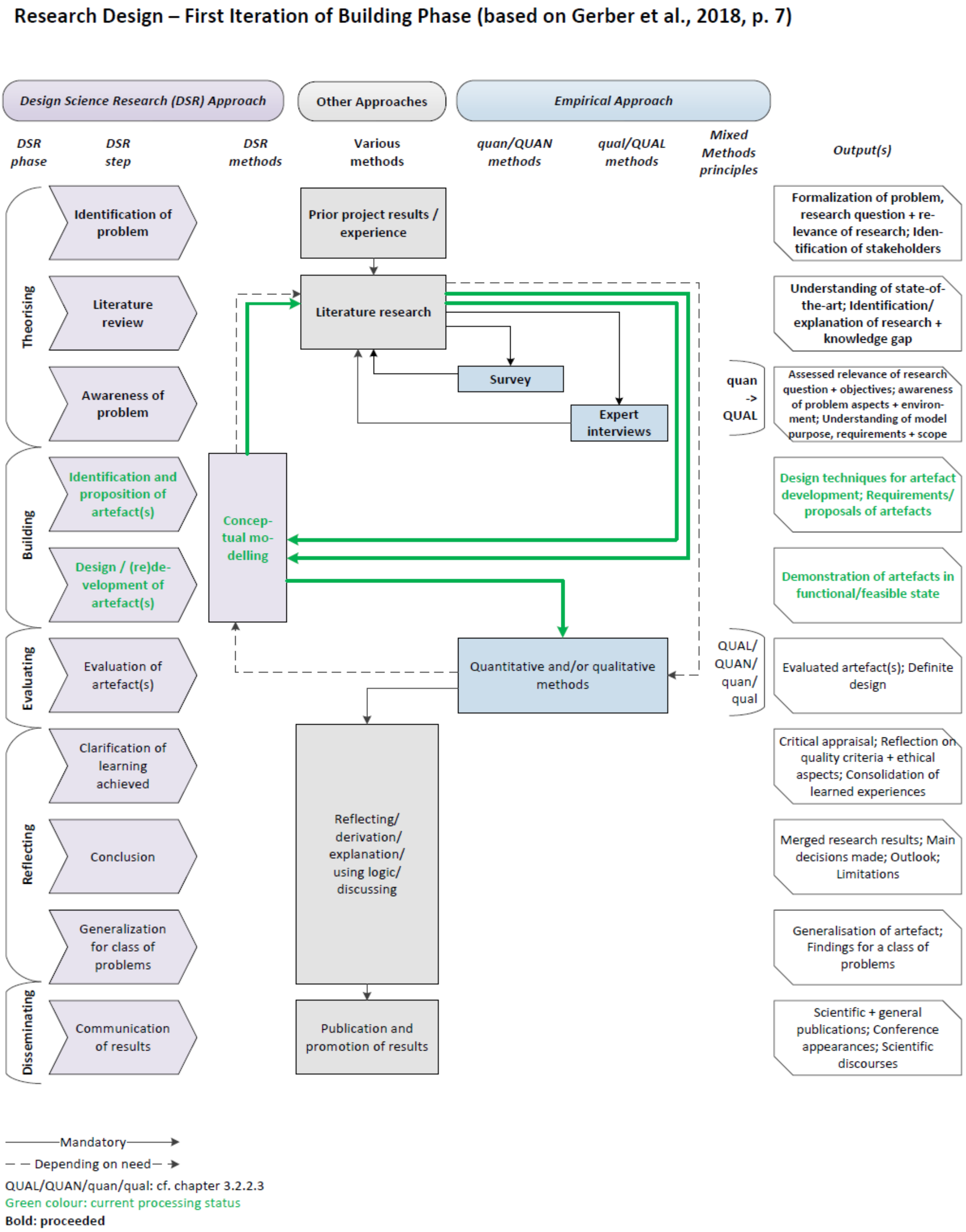

Figure 38: Illustration of the modelling actions in the first iteration of the “Building” phase within the overall research design

4.2.3 Modelling Actions Conducted in the Second Iteration of the “Building” Phase

The goal of the second iteration of the “Building” phase was to implement the findings from the first iteration of the “Evaluating” phase (cf. subsection 4.3.1 et seq.) in order to reach an increased model quality. In this subsection, the relevant content to involve for the model adaptation derived from the analysis of the first iteration of the “Evaluating” phase, the applied re-modelling methods and the final procedure reference model are presented.

4.2.3.1 Relevant Content from the Analysis of the First Iteration of the “Evaluating” Phase to Involve in the Second “Building” Iteration

The analysis of the first iteration of the “Evaluating” phase (cf. subsection 4.3.1.8) reveals the following actions needed for the re-building:
Corrections in models:

- changing of “Transaction” into “Grouping” in meta and procedure model
- inclusion of “(Sub)Process” in meta and procedure model
- alignment of term “Activity”
- introduction of missing “No” in II.R4 in component model

Improvements in models:

- introduction of consistent colours in models and input documents
- reduction of in-/output documents: drop illustration within procedure model, shorter names incl. indication of Excel in procedure model; use gained space for more detailed illustration (particularly for remaining texts)
- emphasize text before lines
- better visibility of IDs in procedure and component models
- introduction of arrow heads in procedure and component models
- check for possibility of summarising for small contexts

Nice to haves in models:

- two-directed ERM notation in metamodel
- check for clearer differentiation between I as a letter and I as a Roman number
- easier connection between Excels and documentation
- check for 3D illustrations

Corrections in in-/output Excels:

- exchange of underline for main stakeholder with another symbol (e. g. asterisk)
- verification of correctness of all links

Improvements in in-/output Excels:

- introduction of grouping function, enable further clustering
- introduction of legend / comments for explanations also in Excel 2
- introduction of more indications about KPI background in Excel 2
- interlinking of Excels

- introduction of indication on how to adjust comment cells in Excel

Nice to haves in-/output Excels:

- marking of fields with comments or dropdown possibilities
- check for further merging possibilities of cells
- automation of documents

Corrections in documentation:

- corresponding corrections of describing text in documentation according to above-mentioned changes.

Improvements in documentation:

- explicit indication of effort-benefit-relationship / expected benefit of model application
- more practice-oriented structure and formulations

Nice to haves in documentation:

- link between documentation and model / input documents

4.2.3.2 Re-Modelling Methods applied in the Second Iteration of the "Building" Phase

As in the first iteration of the "Building" phase (cf. subsection 4.2.2.5), experience, creativity, principles of form and function and logic were consciously used out of the modelling methods mentioned in the Design Science Research Cycle for Business and Management Research by Gerber et al. (2018) in Figure 19.

4.2.3.3 Actions conducted in the Second Iteration of the "Building" Phase based on the Analysis of the First Iteration of the "Evaluating" Phase

Based on the inputs described in subsection 4.2.3.1, the corrections were made and improvements were applied as far as possible, most importantly

- the introduction of consistent colours in all artefacts
- the specification of model representations
- the re-structuring of the documentation.

Further inputs were examined, however could not be or were not implemented:

- The introduction of links between the Microsoft Word, Visio and Excel documents is technically impossible in the given context. The interlinks of the documents will therefore be introduced on html basis, once the thesis and thus the documents will officially be published and therefore freely uploadable.
- The grouping function within Microsoft Excel can only be used by introducing additional columns or by implementing macros. However, additional columns would make the table even more complex and macros would impede the implementation of the model artefacts depending on the used configuration, thus contradicting the objective of having a freely available and widely implementable reference model.

- The two-directed ERM notation in the metamodel as suggested by one expert was not pursued, because firstly, the chosen notation is a widely implemented and accepted notation in the field and secondly, because this notation was generally approved by all other interviewed experts.
- The 3D illustrations suggested by one expert were also not implemented firstly because the chosen modelling notation does not include a three dimensional illustration and secondly once again, because all other interviewed experts assessed the chosen notation as appropriate.

4.2.3.4 Critical Reflection of the Modelling Actions Undertaken in the Second Iteration of the "Building" Phase

The critical reflection is conducted based on the quality criteria framework by Gerber et al. (2018). As outlined in section 3.4, firstly integrity and trustworthiness and secondly the contextual rigour demonstrated in this iteration will be discussed in this subsection.

4.2.3.5 Critical Reflection on Integrity and Trustworthiness in the Second Iteration of the "Building" Phase

The critical reflection on integrity and trustworthiness in the second iteration of the "Building" phase turned out to be identical to the critical reflection on integrity and trustworthiness in the first iteration of the "Building" phase (cf. subsection 4.2.2.7.1).

4.2.3.6 Critical Reflection on Contextual Rigour in the Second Iteration of the "Building" Phase

As outlined in subsection 4.2.2.7.2, with the decision to apply the Design Science Research approach, the inherent corresponding quality criteria were explicitly observed, not only during the setup of the research design and the modelling actions in the first iteration of the "Building" phase, but also in this second iteration of the "Building" phase, where the design aspects could be enhanced due to a systematic assessment and validation based on existing frameworks during the first iteration of the "Evaluating" phase (cf. subsection 4.3.1). The epistemic validation was explicitly planned to be assessed in the second iteration of the "Evaluating" phase.

4.2.3.7 Chapter Summary of the Second Iteration of the "Building" phase – Presentation of the Procedure Reference Model and its Integral Parts

The goal of the second iteration of the "Building" phase was to implement the findings from the first iteration of the "Evaluating" phase in order to reach a better model quality. Based on the analysis of the first iteration of the "Evaluating" phase (cf. subsection 4.3.1.7), the procedure reference model including its integral parts was corrected where necessary, slightly redesigned and adapted. The major re-modelling actions were

- the introduction of consistent colours in all artefacts
- the specification of model representations
- the re-structuring of the documentation

The re-modelled and finalised artefacts are presented in the following subsections.

In Figure 39, the modelling actions conducted in the second iteration of the “Building” phase are shown within the overall research design.

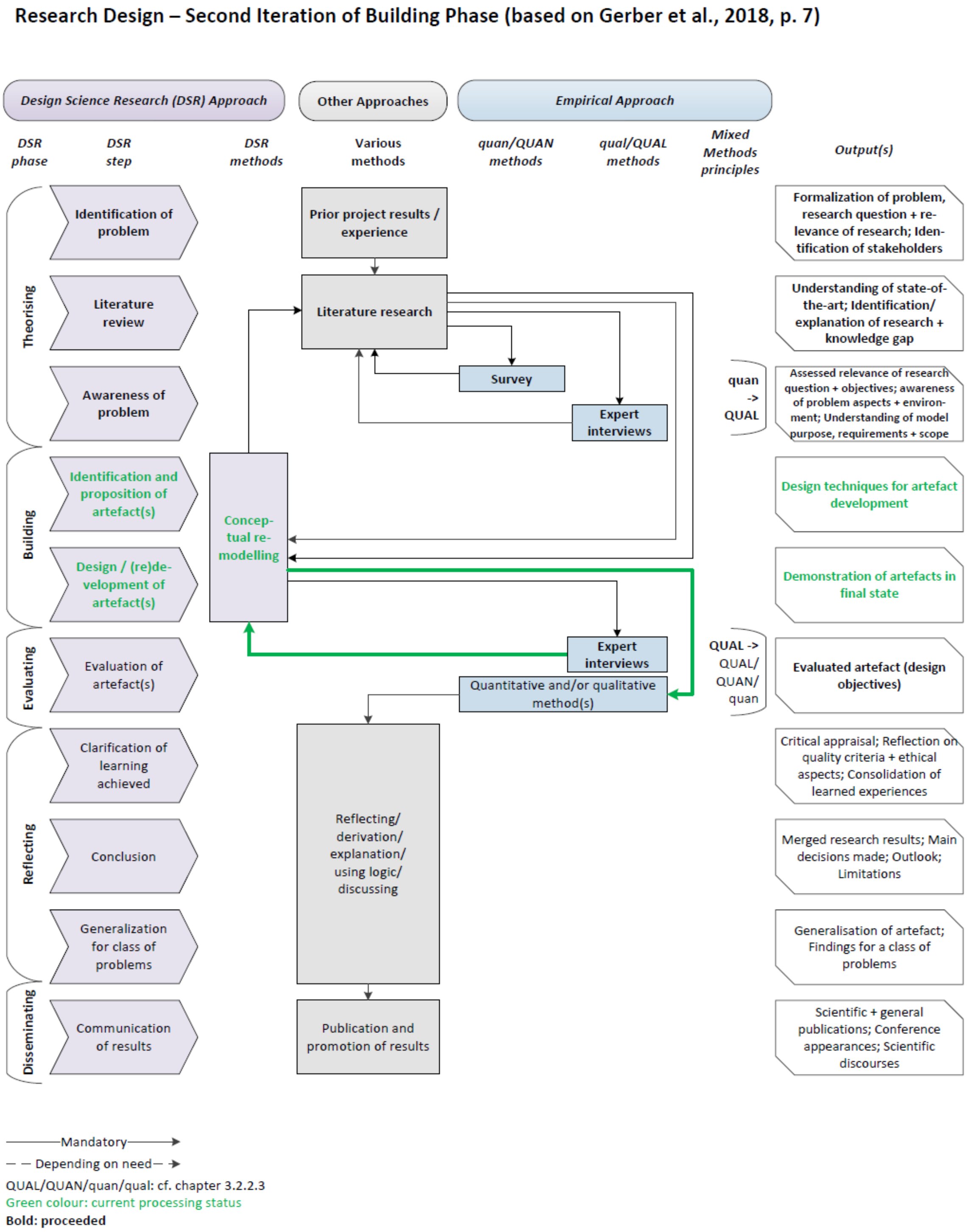

Figure 39: Illustration of the modelling actions in the second iteration of the “Building” phase within the overall research design

4.2.3.8 Procedure Reference Model for the Alignment of Non-Medical Support Service Applications in Hospitals

The procedure reference model for the alignment of non-medical support service applications in hospitals consists of

- the illustration of the model including the legend of its corresponding modelling language notation
- six component models including a tabular step by step instruction
- two input documents in Microsoft Excel table form
- the documentation for application, explaining how to apply the model

The procedure reference model for the alignment of non-medical support service applications in hospitals is presented in Figure 40 and its corresponding modelling language notation is shown in Figure 41.

The procedure reference model consists of two iterations:

- the KPI Assessment Iteration [I] and
- the Socio-technical Analysis Iteration [II]

Each iteration consists of three component models.
The KPI Assessment Iteration [I] includes the three sub-processes

- KPI Stakeholder Involvement Assessment
- KPI Parameter Assessment
- KPI Reporting Need Assessment

The Socio-technical Analysis Iteration [II] includes the three sub-processes

- Stakeholder Management
- KPI Reporting Implementation Analysis
- Application Alignment Analysis

The stakeholder management was put in the centre of the model also visually as preceding findings had shown that the crucial part was not the technical implementation, but the stakeholder management.

The primary procedure principle is iterativeness, both within as well as between the two iterations. The iterations can, according to the specific need, be proceeded in varying sequence as often as necessary and/or desired.

All model parts, the input documents and the documentation will – after the approval of this thesis – be freely accessible and will be able to be used and adapted according to the need of the implementation context.

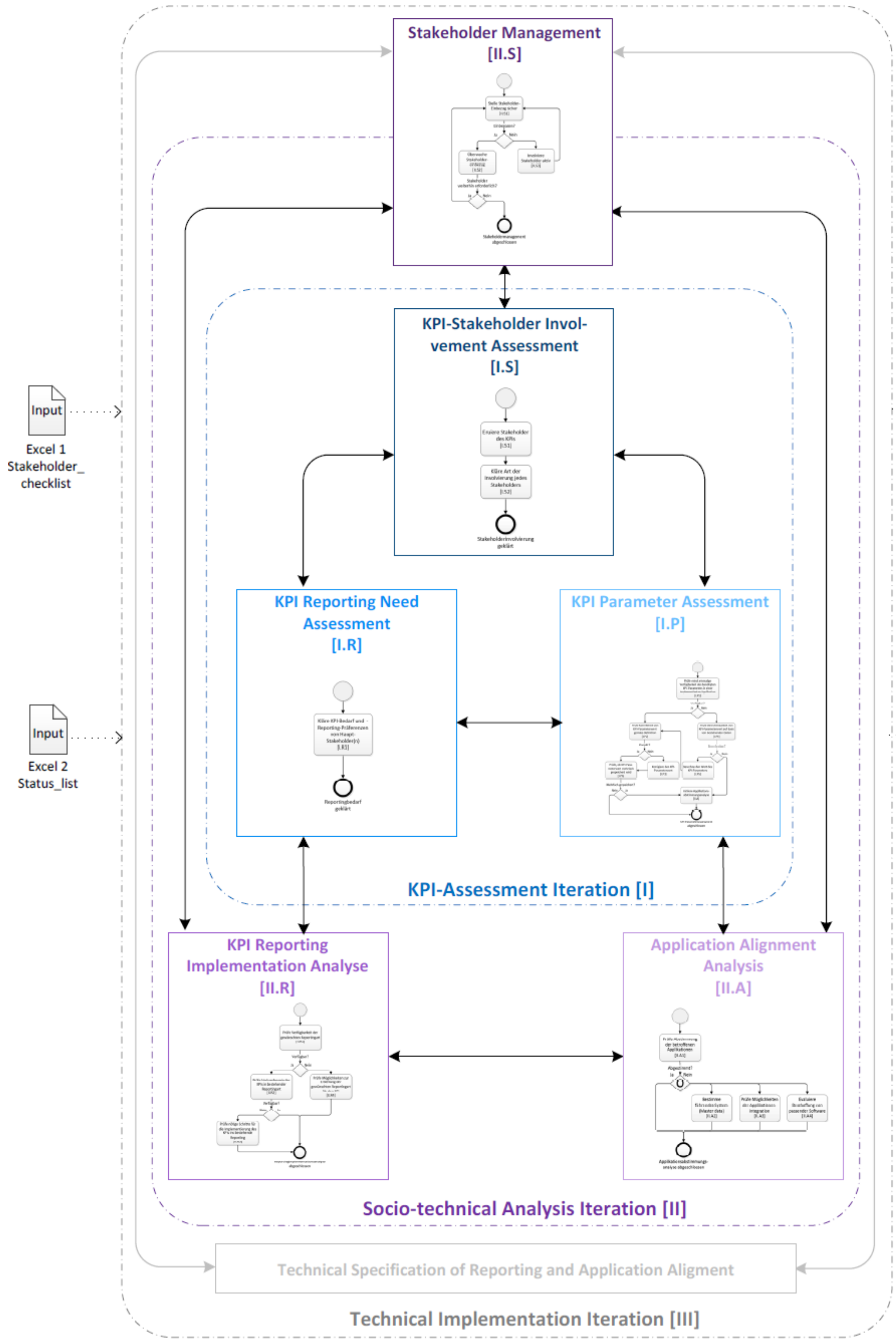

Figure 40: Procedure reference model for the alignment of non-medical support service applications in hospitals

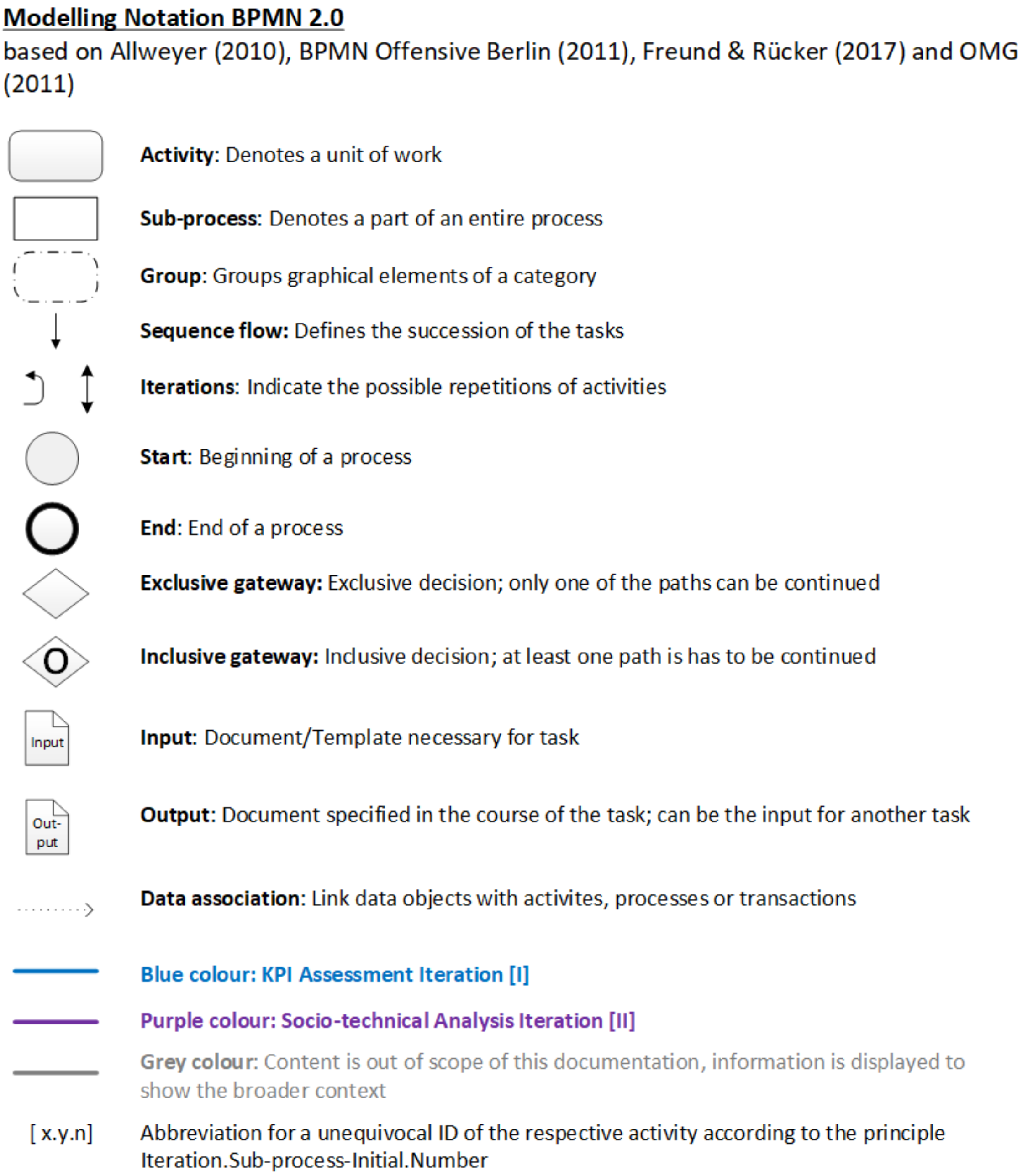

Figure 41: Modelling language notation of procedure reference model for the alignment of non-medical support service applications in hospitals

4.2.3.9 Component Models

The procedure reference model for the alignment of non-medical support service applications in hospitals consists of six component models showing the sub-processes

- KPI Stakeholder Involvement Assessment
- KPI Parameter Assessment
- KPI Reporting Need Assessment
- Stakeholder Management
- KPI Reporting Implementation Analysis
- Application Alignment Analysis

The component models are displayed in Figure 42 – Figure 47, each complemented with a tabular explanation of the process steps as shown in Table 17 – Table 22.

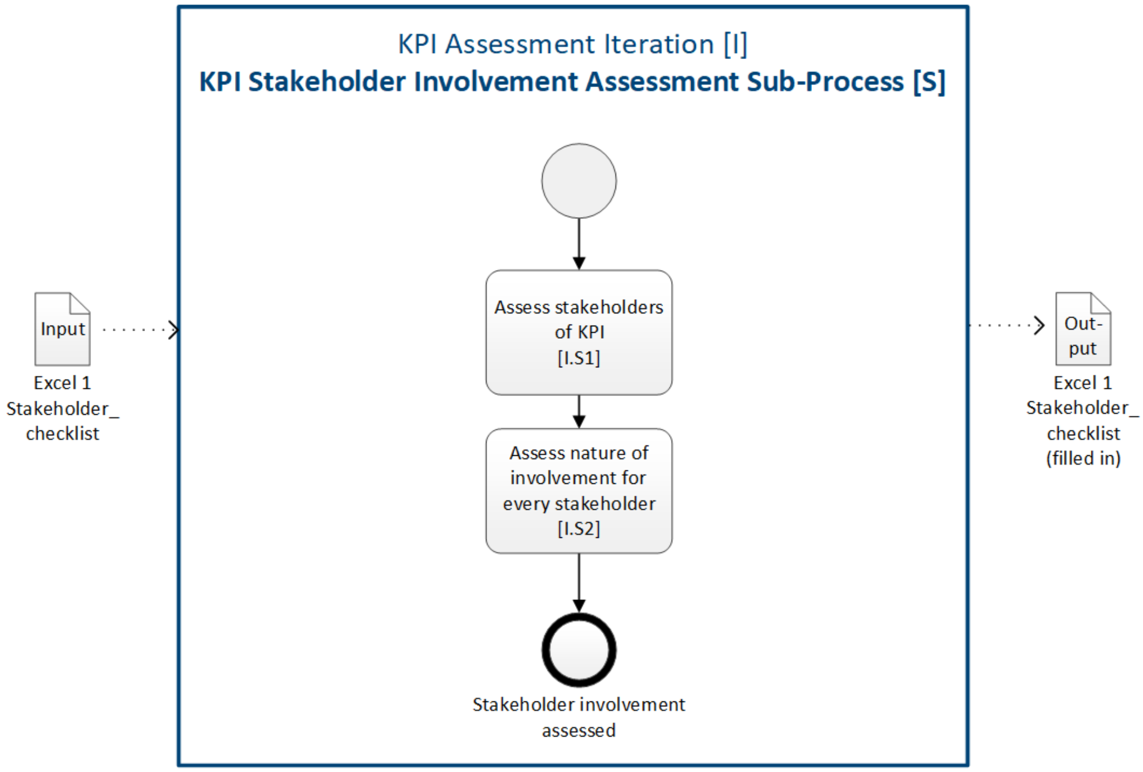

Figure 42: Component Model KPI Stakeholder Involvement Assessment

Table 17: Tabular Explanation KPI Stakeholder Involvement Assessment

ID	Activity	Explanation
I.S1	Asses stakeholders of KPI	The input document serves as a checklist for identifying the stakeholders of the desired/required KPI. The goal is that all the essential stakeholders from the different areas are known in order to facilitate stakeholder management The input document has to be filled in accordingly.
I.S2	Assess nature of involvement for every stakeholder	In order to derive the stakeholder management measures, it is important to clarify in what form and to what extent a stakeholder is involved in the further process. The input document has to be filled in accordingly.

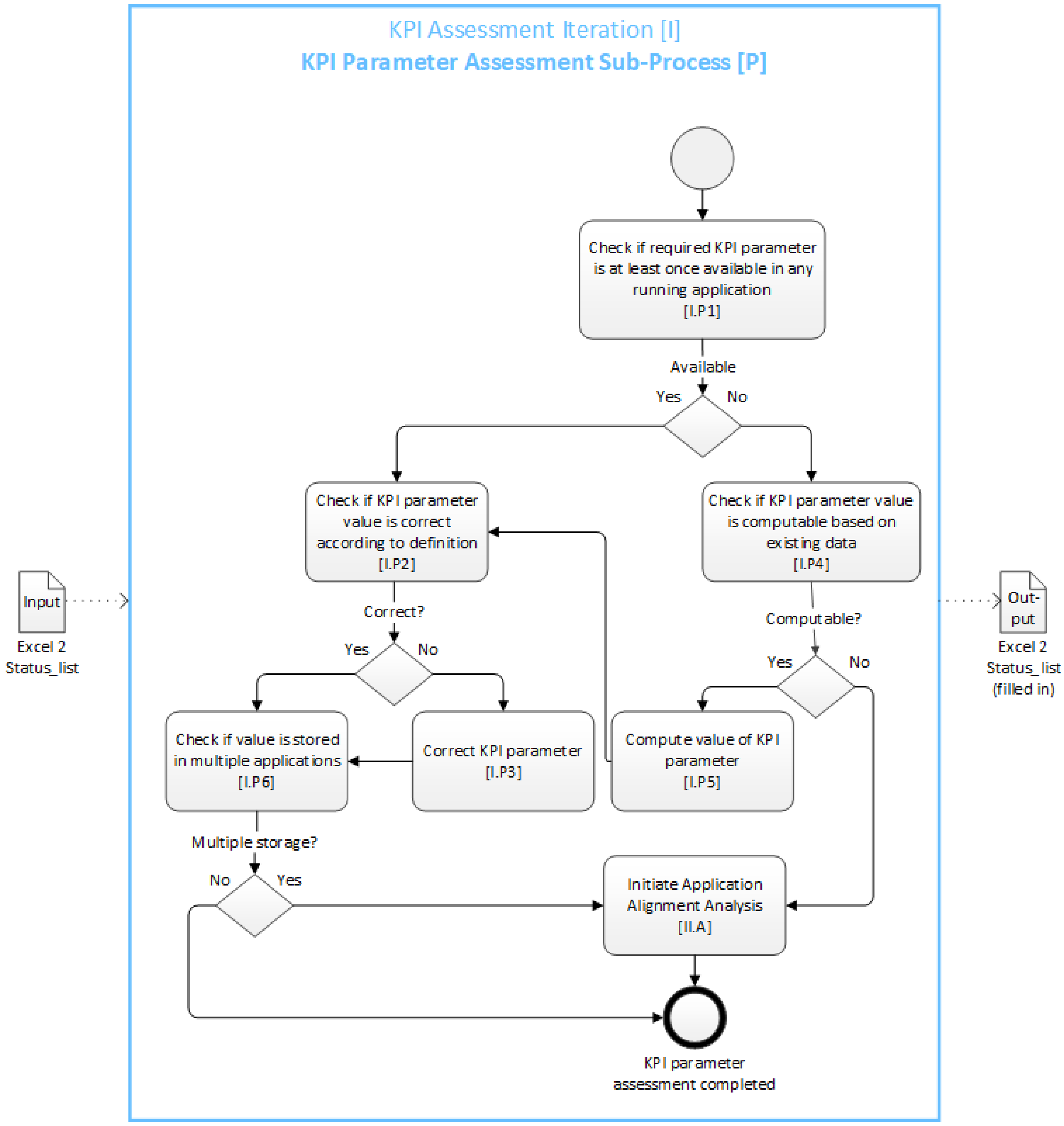

Figure 43: Component KPI Parameter Assessment

Table 18: Tabular Explanation KPI Parameter Assessment

ID	Activity	Explanation
I.P1	Check if required KPI parameter is at least once available in any running application	Is the desired/necessary KPI and its parameters available at least once in any application? The input document has to be filled in accordingly.
I.P2	Check if KPI parameter value is correct according to definition	Is the desired/necessary KPI and its parameters correct according to the KPI definition (either defined in-house or under https://www.zhaw.ch/en/lsfm/institutes-centres/ifm/about-us/hospitality-management/fm-in-healthcare/remos/kenkas/. The input document has to be filled in accordingly.
I.P3	Correct KPI parameter	If the value is not correct according to the definition, it has to be corrected with the appropriate measures. The input document has to be filled in accordingly.

Continued

Table 18: Tabular Explanation KPI Parameter Assessment - Continued

I.P4	Check if KPI parameter value is computable based on existing data	If the desired/necessary KPI parameter value is not yet available, check if the value can be calculated according to the definition on the basis of the available partial values. The input document has to be filled in accordingly.
I.P5	Compute value of KPI parameter	If the desired/necessary KPI parameter values can be calculated on the basis of available partial values, the calculation has to be executed. The input document has to be filled in accordingly.
I.P6	Check if value is stored in multiple applications	In order to avoid redundancies, check if the KPI parameter is stored in multiple applications. The input document has to be filled in accordingly.
IIA	Initiate Application Alignment Analysis (II.A)	cf. Figure 47 and Table 22

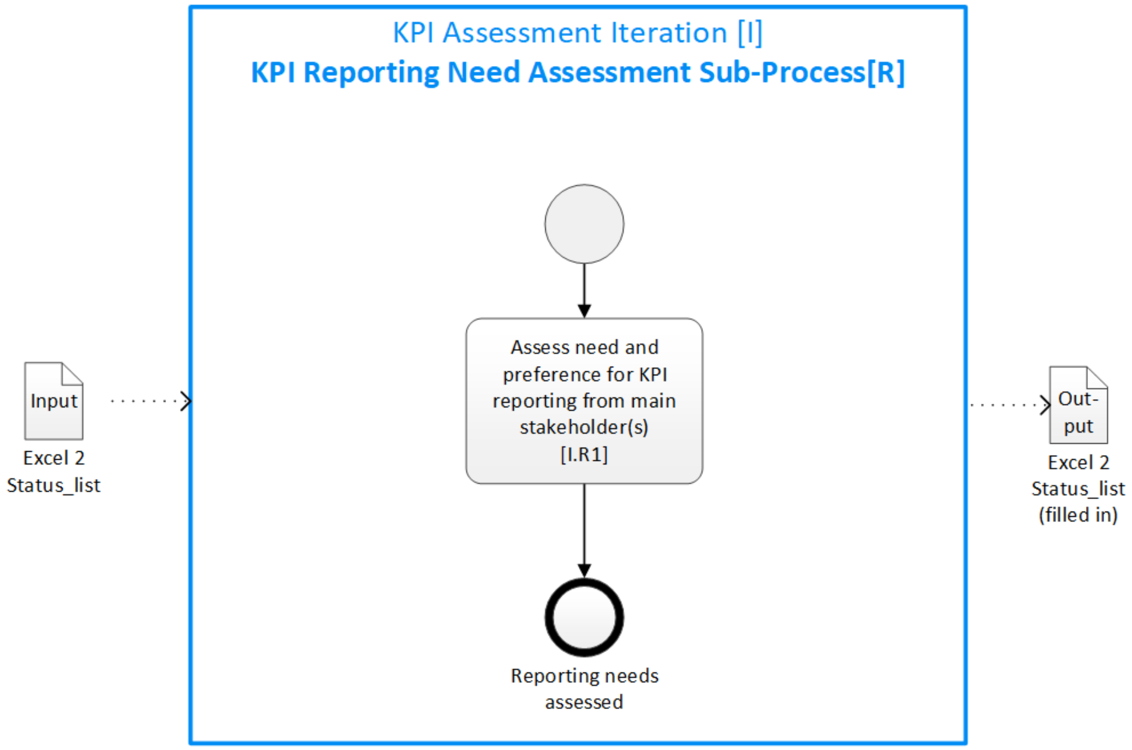

Figure 44: Component Model KPI Reporting Need Assessment

Table 19: Tabular Explanation KPI Reporting Need Assessment

ID	Activity	Explanation
I.R1	Assess need and preference for KPI reporting from main stakeholder(s)	The input document supports the assessment of the KPI need and the reporting preferences. The goal is to carry out the KPI reporting as optimally as possible with respect to the cost-benefit relationship. The input document has to be filled in accordingly.

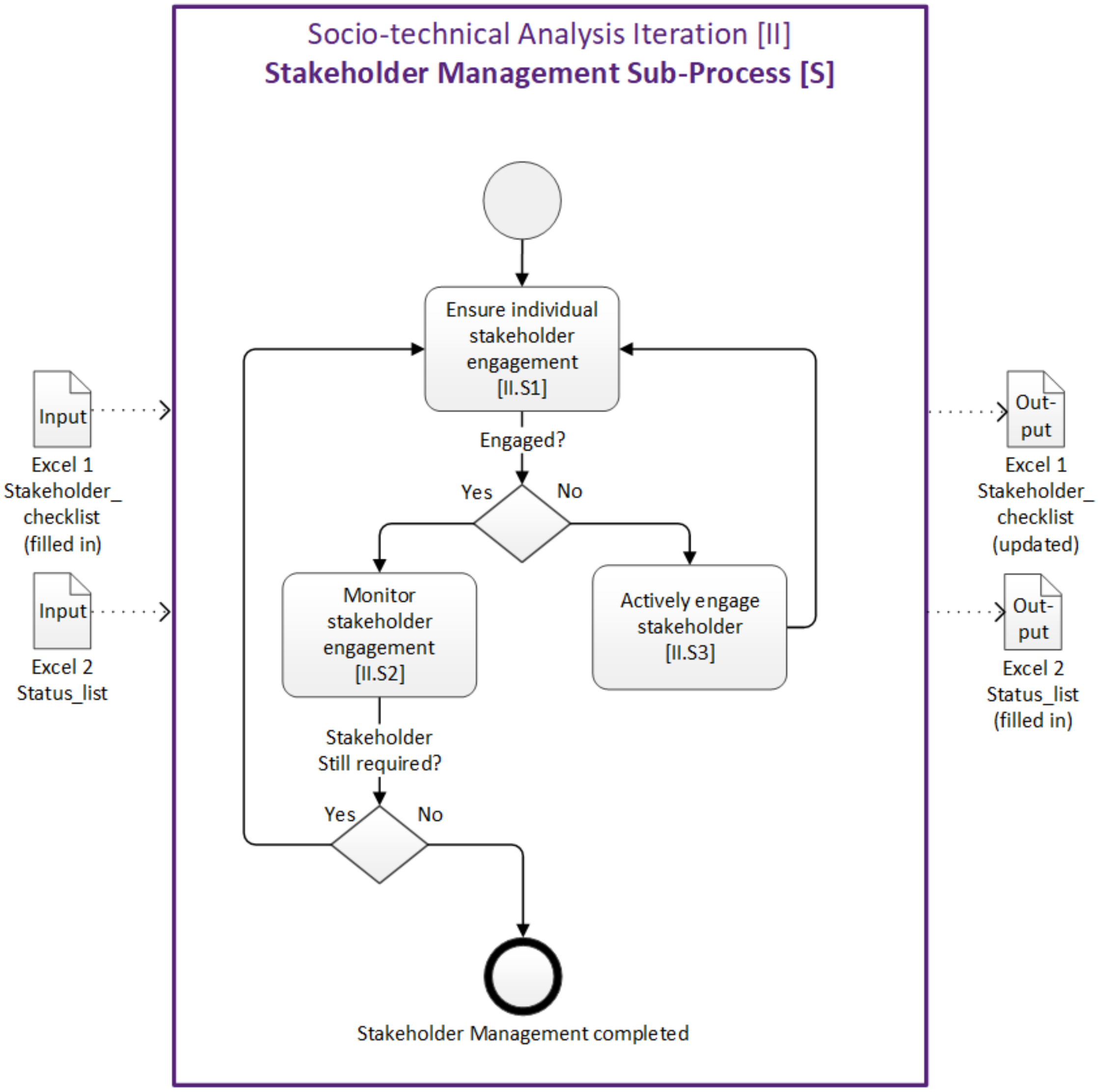

Figure 45: Component Model Stakeholder Management

Table 20: Tabular Explanation Stakeholder Management

ID	Activity	Explanation
II.S1	Ensure individual stakeholder engagement	In addition to the content and technological related aspects, it is important, to pursue sensible stakeholder management. It is important that the engagement of stakeholders is continuously secured. The input document has to be filled in accordingly.
II.S2	Monitor stakeholder engagement	The assurance of stakeholder engagement has to be consciously monitored regularly. The input document has to be filled in accordingly.
II.S3)	Actively engage stakeholder	If the engagement of stakeholders is not secured, the engagement has to be actively induced. The input document has to be filled in accordingly.

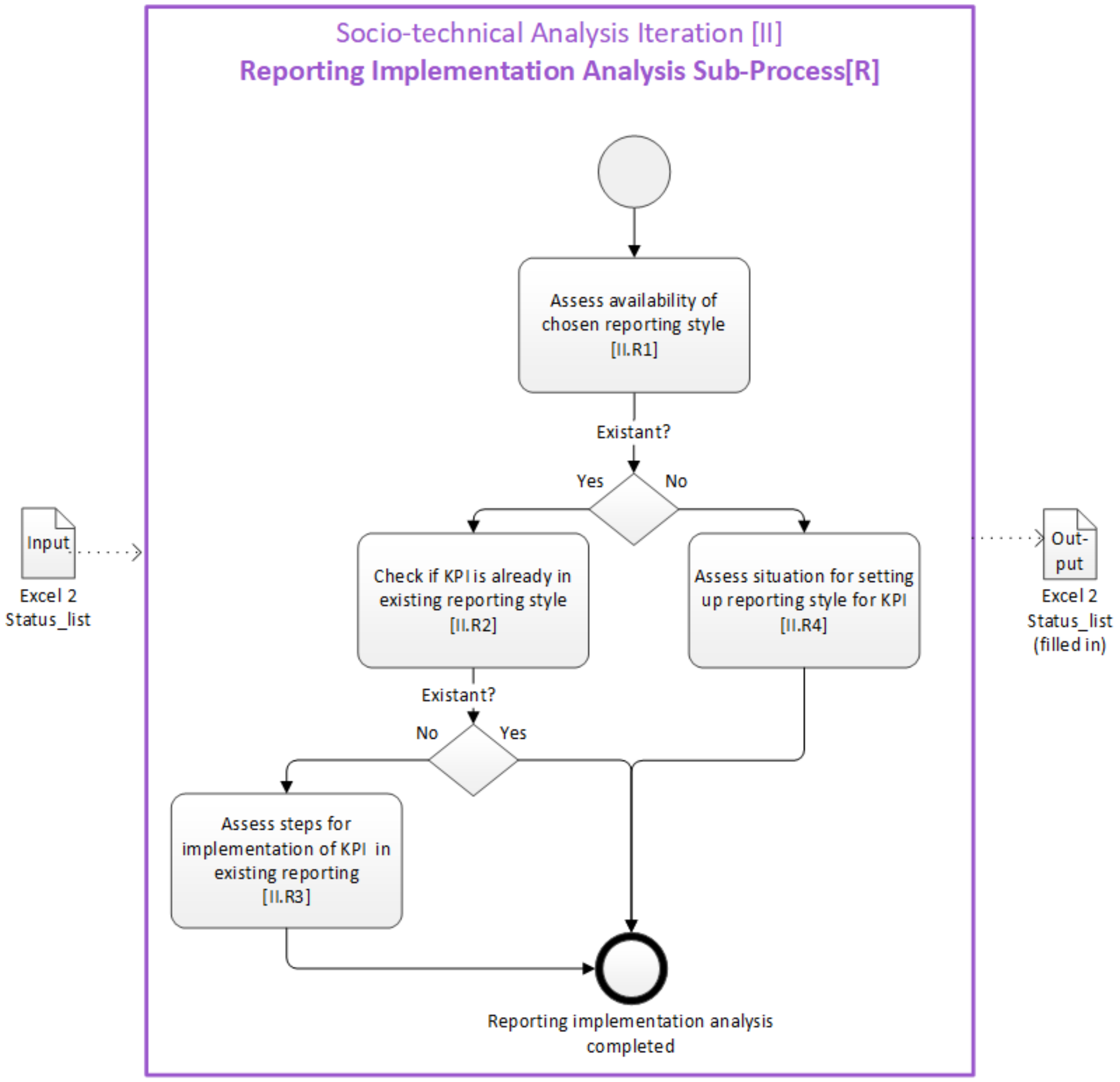

Figure 46: Component Model KPI Reporting Implementation Analysis

Table 21: Tabular Explanation KPI Reporting Implementation Analysis

ID	Activity	Explanation
II.R1	Assess availability of chosen reporting style	It must be clarified whether the desired reporting style of the main stakeholder is already being applied. The input document has to be filled in accordingly.
II.R2	Check if KPI is already in existing reporting style	If the reporting style is available, clarify if the concerned KPI is already or could be configured. The input document has to be filled in accordingly.
II.R3	Assess steps for implementation of KPI in existing reporting	If the concerned KPI is not yet configured in the desired reporting style, check if the KPI can be implemented. The input document has to be filled in accordingly.
II.R4	Assess situation for setting up reporting style for KPI	If the reporting style is not available, check if the desired reporting style can be set up and implemented. The input document has to be filled in accordingly.

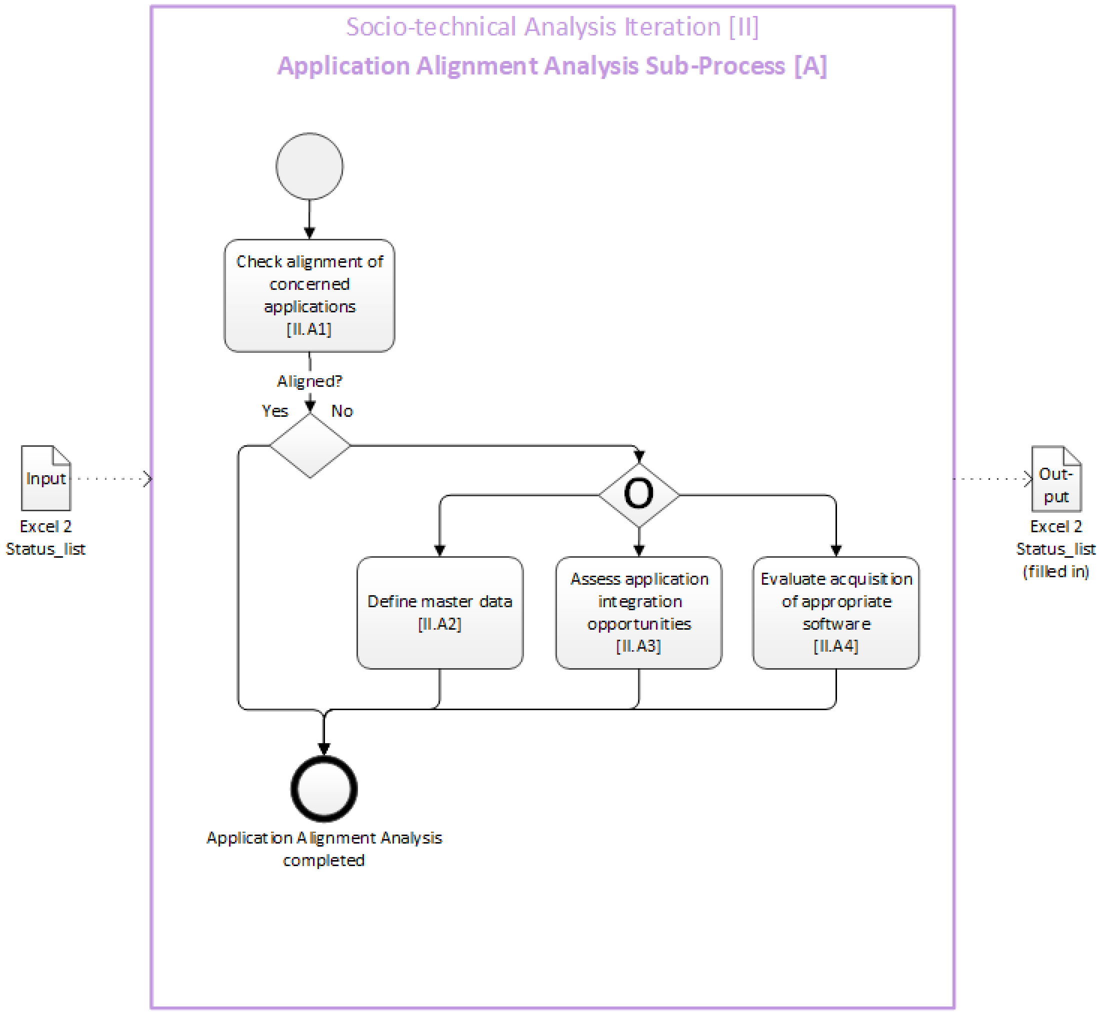

Figure 47: Component Model Application Alignment Analysis

Table 22: Tabular Explanation Application Alignment Analysis

ID	Activity	Explanation
II.A1	Check alignment of concerned applications	The goal is to reach a compatible, redundancy-free application alignment. Therefore, it must be clarified whether the applications involved in the KPI reporting are aligned. The input document has to be filled in accordingly.
II.A2	Define master data	If the applications involved in the KPI reporting are not aligned, it has to be clarified which of the existing systems is the leading one. The input document has to be filled in accordingly.
II.A3	Assess application integration opportunities	If the applications involved in the KPI reporting are not aligned, the possibilities for an application integration should be assessed. The input document has to be filled in accordingly.
II.A4	Evaluate acquisition of appropriate software	If the applications involved in the KPI reporting are not aligned, the acquisition of a suitable software can be evaluated. The input document has to be filled in accordingly.

The application of the component models in practice is described in detail in the documentation in Appendix 10.

4.2.3.10 Input Documents

There are two input documents of the procedure reference model for the alignment of non-medical support service applications:

- Excel1_Stakeholder_checklist.xlsx
- Excel2_Status_list.xlsx.

Both documents contain a neutral template in the first sheet and then 15 sheets pre-filled with the KPIs developed by Gerber et al. (2017a) for every non-medical support service (cf. subsections 2.4.2).

Figure 48 illustrates the first sheet and as such the neutral template of the input document Excel1_Stakeholder_checklist, Figure 49 exemplary for all subject-areas the second sheet of the Excel1_Stakeholder_checklist, subject-area “Procurement”. The same applies for Figure 50 showing the first sheet and as such the neutral template of the input document Excel2_Status_list and Figure 51 the second sheet of the Excel2_Status_list, again exemplary for all subject-areas the subject-area “Procurement”. A legible version of the documents can be found in Appendix 11 and Appendix 12.

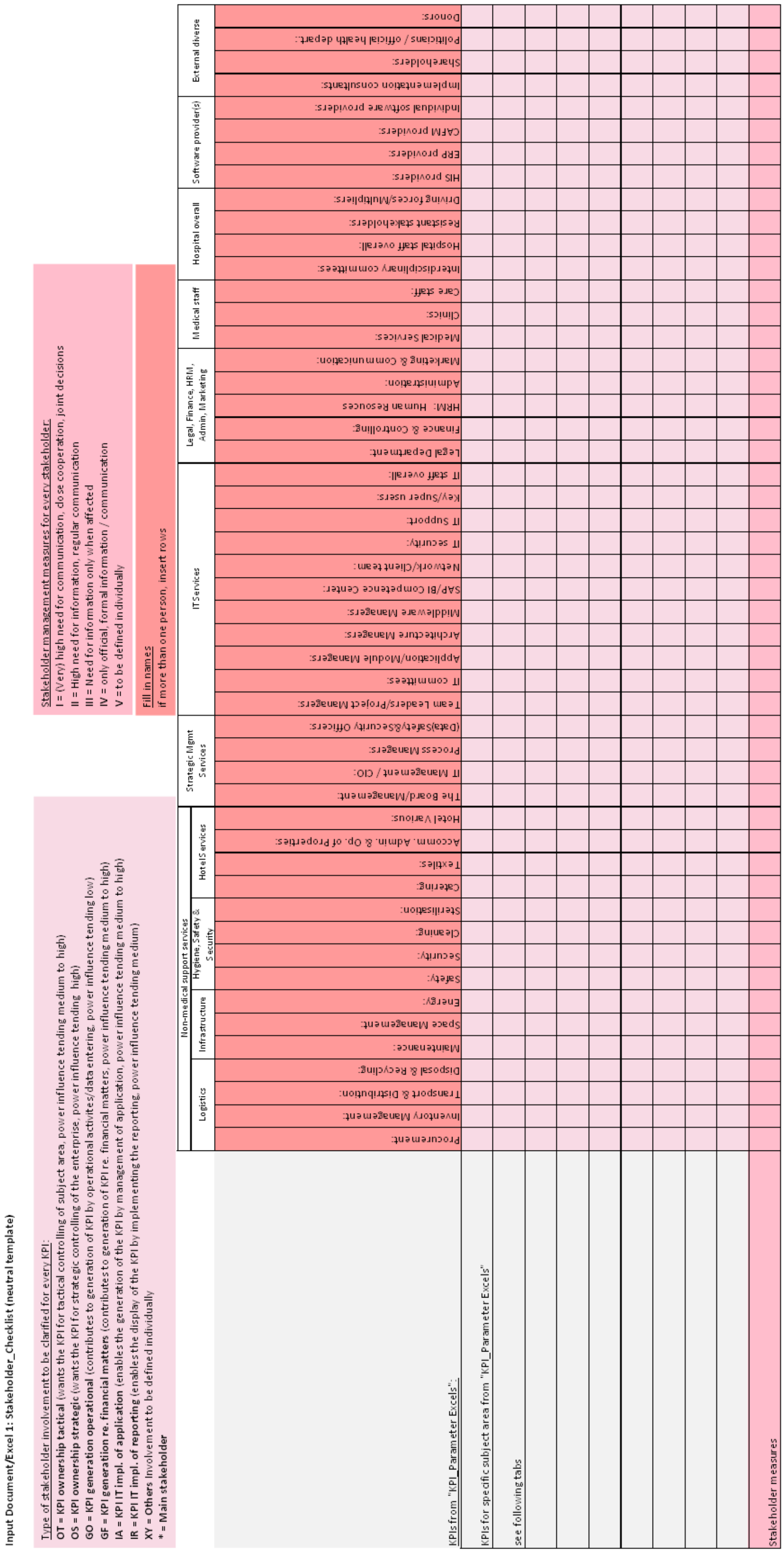

Figure 48: First sheet of input document Excel1_Stakeholder_checklist

Input Document/Excel 1: Stakeholder_Checklist Subject-area Procurement

Type of stakeholder involvement to be clarified for every KPI:
OT = KPI ownership tactical (wants the KPI for tactical controlling of subject area, power influence tending medium to high)
OS = KPI ownership strategic (wants the KPI for strategic controlling of the enterprise, power influence tending high)
GO = KPI generation operational (contributes to generation of KPI by operational activites/data entering, power influence tending low)
GF = KPI generatiion re. financial matters (contributes to generation of KPI re. financial matters, power influence tending medium to high)
IA = KPI IT impl. of application (enables the generation of the KPI by management of application, power influence tending medium to high)
IR = KPI IT impl. of reporting (enables the display of the KPI by implementing the reporting, power influence tending medium)
XY = Others Involvement to be defined individually
*** = Main stakeholder**

Stakeholder management measures for every stakeholder:
I = (Very) high need for communication, close cooperation, joint decisions
II = High need for information, regular communication
III = Need for information only when affected
IV = only official, formal information / communication
V = to be defined individually

Fill in names
if more than one person, insert rows

	Non-medical support services															Strategic Mgmt Services				IT Services											Legal, Finance, HRM, Admin, Marketing					Medical staff			Hospital overall				Software provider(s)				External diverse			
	Logistics				Infrastructure			Hygiene, Safety & Security				Hotel Services																																						
KPIs from "KPI_Parameter Excels":	Procurement:	Inventory Management:	Transport & Distribution:	Disposal & Recycling:	Maintenance:	Space Management:	Energy:	Safety:	Security:	Cleaning:	Sterilisation:	Catering:	Textiles:	Accomm. Admin. & Op. of Properties:	Hotel Various:	The Board/Management:	IT Management / CIO:	Process Managers:	(Data)Safety&Security Officers:	Team Leaders/Project Managers:	IT committees:	Application/Module Managers:	Architecture Managers:	Middleware Managers:	SAP/BI Competence Center:	Network/Client team:	IT security:	IT Support:	Key/Super users:	IT staff overall:	Legal Department:	Finance & Controlling:	HRM: Human Resouces	Administration:	Marketing & Communication:	Medical Services:	Clinics:	Care staff:	Interdisciplinary committees:	Hospital staff overall:	Resistant stakeholders:	Driving forces/Multipliers:	HIS providers:	ERP providers:	CAFM providers:	Individual software providers:	Implementation consultants:	Shareholders:	Politicians / official health depart.:	Donors:
Proportion of costs of externally rendered procurement services in %: Costs of externally rendered procurement services / Total costs of rendered procurement services * 100																																																		
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Proportion of the goods value of non-medical procurement to the total goods value in the subject area of procurement: Goods value of medical procurement / Total goods value in the subject area of procurement * 100																																																		
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Proportion of personnel expenditures in the subject area of procurement to goods value in the subject area of procurement: Personnel expenditures in the subject area of procurement / Goods value in the subject area of procurement																																																		
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Number of effective throughput times of all executed orders																																																		
Total number of executed orders																																																		
Stakeholder measures																																																		

Figure 49: Second sheet of input document Excel1_Stakeholder_checklist (pre-filled KPIs of subject-area Procurement)

Input Document/Excel 2: Status List for the Analysis and Specification of the Alignment of Applications of Non-Medical Support Services in Hospitals (Template)

1. Enter the desired KPIs in column A
2. Fill in the list (please not the comment fields and/or the accompanying documentation)

	KPI Parameter Assessment [I.P]				KPI Reporting Need Assessment [I.R]	KPI Reporting Implementation Analysis [II.R]				Application Alignment Analysis [II.A]					Stakeholder Management [II.S]	
Own KPIs or subject-area KPIs from "KPI_Parameter Excels" https://www.zhaw.ch/en/lsfm/institutes-centres/ifm/about-us/hospitality-management/fm-in-healthcare/remos/kenkas	[I.P1] KPI Parameter available at least once? (dropdown function)	[I.P2 + I.P3] Correctness of KPI parameter checked by: (cf. comment field)	[I.P4 + I.P5] If necessary: Following data aggregation for missing KPI parameter compilation: (cf. comment field)	[I.P6] KPI parameter stored in various applications? (dropdown function)	[I.R1] Reporting need of main stakeholder(s)? (cf. comment field)	[II.R1] Requested reporting form already available/in use? (dropdown function)	[II.R2] KPI already available in requested reporting form? (dropdown function)	[II.R3] If KPIs has to be integrated in existing reporting form: Necessary steps:	[II.R4] If requested reporting is not yet available: Necessary steps for implementation:	[II.A1] List of application(s) involved for the compilation of the KPI	[II.A1] If various involved applications: Applications aligned? (dropdown function)	[II.A2] If various applications exist in parallel: Which system is the master?	[II.A3] In case of various non-aligned applications: Integration possible? (dropdown function)	[II.A4] If no available application/integration: Acquisition of software possible? (dropdown function)	Stakeholder involvement ensured? (cf. comment field; drop down function)	If no stakeholder involvement: planned measures: (cf. comment field)

Figure 50: First sheet of input document Excel2_Status_list

Input Document/Excel 2: Status List for the Analysis and Specification of the Alignment of Applications of Non-Medical Support Services in Hospitals Subject-area Procurement

1. Enter the desired KPIs in column A
2. Fill in the list (please not the comment fields and/or the accompanying documentation)

	KPI Parameter Assessment [I.P]				KPI Reporting Need Assessment [I.R]	KPI Reporting Implementation Analysis [II.R]				Application Alignment Analysis [II.A]					Stakeholder Management [II.S]	
Own KPIs or subject-area KPIs from "KPI_Parameter Excels" https://www.zhaw.ch/en/lsfm/institutes-centres/ifm/about-us/hospitality-management/fm-in-healthcare/remos/kenkas	[I.P1] KPI Parameter available at least once? (dropdown function)	[I.P2 + I.P3] Correctness of KPI parameter checked by: (cf. comment field)	[I.P4 + I.P5] If necessary: Following data aggregation for missing KPI parameter compilation: (cf. comment field)	[I.P6] KPI parameter stored in various applications? (dropdown function)	[I.R1] Reporting need of main stakeholder(s)? (cf. comment field)	[II.R1] Requested reporting form already available/in use? (dropdown function)	[II.R2] KPI already available in requested reporting form? (dropdown function)	[II.R3] If KPIs has to be integrated in existing reporting form: Necessary steps:	[II.R4] If requested reporting is not yet available: Necessary steps for implementation:	[II.A1] List of application(s) involved for the compilation of the KPI	[II.A1] If various involved applications: Applications aligned? (dropdown function)	[II.A2] If various applications exist in parallel: Which system is the master?	[II.A3] In case of various non-aligned applications: Integration possible? (dropdown function)	[II.A4] If no available application/integration: Acquisition of software possible? (dropdown function)	Stakeholder involvement ensured? (cf. comment field; drop down function)	If no stakeholder involvement: planned measures: (cf. comment field)
Proportion of costs of externally rendered procurement services in %: Costs of externally rendered procurement services / Total costs of rendered procurement services * 100																
Costs of externally rendered procurement services																
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Total costs in the subject area of procurement per inpatient case: Total costs in the subject area of procurement / Number of inpatient cases																
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Total costs in the subject area of procurement per outpatient case: Total costs in the subject area of procurement / Number of outpatient cases																
Total costs in the subject area of procurement																
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Total costs in the subject area of procurement per care day: Total costs in the subject area of procurement / Number of care days																
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Total costs in the subject area of procurement in relation to the total costs of the hospital: Total costs in the subject area of procurement / Total costs of the hospital																
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Proportion of the goods value of non-medical procurement to the total goods value in the subject area of procurement: Goods value of medical procurement / Total goods value in the subject area of procurement * 100																
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Total goods value in the subject area of procurement																
Ratio of goods value medical procurement vs. non-medical procurement: Goods value of medical procurement / Goods value of non-medical procurement																
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Goods value of non-medical procurement																
Total costs in the subject area of procurement per number of order item: Total costs in the subject area of procurement / Total number of order items																
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Total number of order items																
Proportion of personnel expenditures in the subject area of procurement to goods value in the subject area of procurement: Personnel expenditures in the subject area of procurement / Goods value in the subject area of procurement																
Personnel expenditures in the subject area of procurement																
Goods value in the subject area of procurement																
Average throughput time order processing: Number of effective throughput times of all executed orders / Total number of executed orders																
Number of effective throughput times of all executed orders																
Total number of executed orders																

Figure 51: Second sheet of input document Excel2_Status_list (pre-filled KPIs of subject-area Procurement)

By continuously filling in the sheets, the input documents become the output documents of the processes.

The application of the input documents in practice is described in detail in the documentation in Appendix 10.

4.2.3.11 Metamodel

The procedure reference model for the alignment of non-medical support service applications in hospitals is based on the metamodel presented in Figure 52. The metamodel was set up with the Modified Entity Relationship Model notation (Modified Chen-Notation) based on Academic dictionaries and encyclopedias (n.d.)., Chen (1976), Chen (1981), Chen (1991) and Chen (2002).

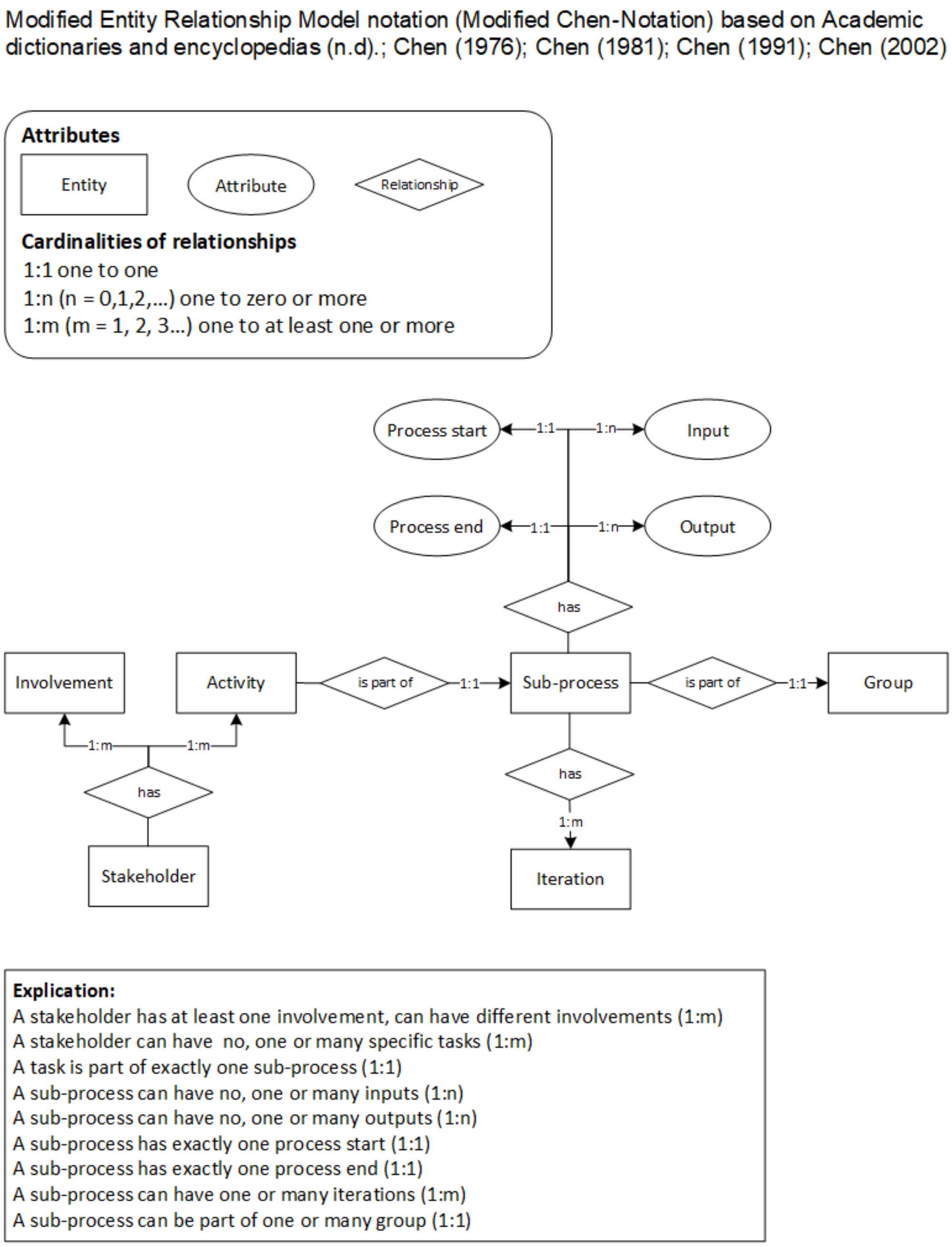

Figure 52: Metamodel of the procedure reference model for the alignment of non-medical support service applications in hospitals

4.2.3.12 Documentation

As presented in Appendix 10, the documentation is divided into three parts:

- Part 1: Introduction / objectives / benefits
- Part 2: Instructions for the application in practice
- Part 3: Background information

Its context is literally self-explanatory.

4.2.4 Summary of the “Building” Phase

The goal of the “Building” phase according to Gerber et al. (2018) (cf. Figure 19) is to develop artefacts satisfying the given requirements, explicitly choose techniques and tools for artefact development and evaluation and finally demonstrate the artefacts in their functional state.

In a first iteration of the “Building” phase, the following artefacts were developed (cf. Appendix 9):

- a procedure reference model including six component models constructed with the BPMN 2.0 notation using Microsoft Visio as modelling tool
- an underlying metamodel in the Modified Chen Notation also using Microsoft Visio as modelling tool
- two model input documents set up in Microsoft Excel
- a documentation explaining the context and the application of the model

In a second iteration of the “Building” phase, based on the analysis of the first iteration of the “Evaluating” phase,

- consistent colours were introduced in all artefacts
- model representations were specified
- the documentation was re-structured

The final procedure reference model with its integral parts is presented in subsections 4.2.3.8 - 4.2.3.12.

4.3 Research Conducted in the "Evaluating" Phase

In this section, the research conducted in the "Evaluating" phase is presented. The methods were chosen in order to validate the developed procedure reference model in a systematic manner on the basis of the multi-perspective framework for reference model evaluation by Frank (2007a). In the first iteration of the "Evaluating" phase, expert interviews were conducted evaluating the design objectives (cf. subsection 3.2.6.5). In a second iteration, focus group discussions were performed in order to validate the epistemic objectives (cf. subsection 3.2.6.5). The data collection and analysis of both iterations will be explained in detail, concluding with a critical reflection of the research conducted and a summary of each iteration as well as the whole "Evaluating" phase.

4.3.1 Research Conducted in the First Iteration of the "Evaluating" Phase

In this subsection, the research conducted in the first iteration of the "Evaluating" phase is presented. In the first iteration of the "Evaluating" phase, the goal was to validate the design objectives including, as discussed in subsection 3.2.6.4, (formal) correctness, systematic design, clarity, comparability, construction adequacy and language adequacy. In order to reach this goal, problem-centred, semi-structured, face-to-face expert interviews according to Easterby-Smith (2012), Flick (2016), Lamnek (2010), Mayer (2009), Mayring (2016), Meuser and Nagel (2009), Saunders (2016) and Wilson (2014) were chosen as the qualitative data collection method.

Like in the second iteration of the "Theorising" phase, the research was conducted following the steps "sampling", "sensitising concept", "interview guideline", "pre-test", "conducting interviews", "analysis" and "reporting" proposed by Mayer (2009, p. 42), complemented with the steps "transcribing" and "critical reflection" as illustrated in Figure 34.

The steps will be discussed in detail in the following subsections.

4.3.1.1 Target Population and Sampling in the First Iteration of the "Evaluating" Phase

The sampling strategy and the given conditions of the first iteration in the "Evaluating" phase were identical with the sampling strategy of the expert interviews in the first iteration of the "Theorising" phase described in subsections 4.1.2.1. Again it was sampled by people according to Boyatzis (1998) representing hospital ICT staff/managers concerned with non-medical applications and/or hospital ICT architecture as the goal was again to obtain the necessary information and estimates about the current and possible future procedure of integration of data and applications by experts, representing their specific professionalization according to Flick (2016). In order to represent the hospital industry and thus have a high potential for generalization and reflect the complexity of the industry (Flick, 2016), out of the 216 German-speaking hospitals in Switzerland (cf. subsection 4.1.2.1), again a non-probability, purposive heterogeneous population approach according to Saunders et al. (2016) was chosen, trying to include as many hospital categories according to the Federal Office of Public Health (BAG Bundesamt für Gesundheit, 2018) (cf. subsection 2.1.2.5.2) in the sample for the qualitative data collection as possible. First, all participating experts of the second iteration in the "Theorising" phase were contacted again to be experts in the "Evaluating" phase. Half of the sample was still willing and available to participate. The other half was not available due to different business or personal reasons. Thus, additional experts had to be contacted keeping in mind the necessity to cover the above-mentioned diversity of category representation.

4.3.1.2 Sensitising Concept of the First Iteration of the "Evaluating" Phase

The bases for the interview guideline were the multi-perspective framework for evaluating reference models by Frank (2007a) and all the guidelines for modelling principles described in detail in subsections 3.2.6.4 et. seq. Due to the focus of the thesis, within the multi-perspective framework for evaluating reference models by Frank (2007a), only the aspects about type 3 models focusing on "organisational or strategic issues *(business (re-) design*" (p. 124) were selected (cf. Appendix 13).

4.3.1.3 Interview Guideline for the First Iteration of the "Evaluating" Phase

Following the principles of the sensitising concept, a mostly theory-driven semi-structured interview guideline was set up, including mainly theory-driven questions according to Flick (2016). However, as it became clear that the basis failed to explicitly include the aspects of in-/output documents of the model, questions for this aspect were inductively introduced. The questions listed were first of all consolidated and corresponding questions were systematically derived as shown in Appendix 14. The questions were then assigned to epistemic objectives or design objectives (cf. subsections 1.3.2.1 and 1.3.2.2) and further consolidated as shown in Appendix 15. The assigned and consolidated questions were then grouped logically as the basis for setting up the interview guideline (cf. Appendix 16). The final, translated guideline is displayed in a compact manner in Appendix 17.

4.3.1.4 Pre-test in the First Iteration of the "Evaluating" Phase

Like in the second iteration of the "Theorising" phase, the interview guideline was pre-tested in two ways: Firstly, the understandability of the questions and the logic of the setup were challenged by a non-expert in the field. Secondly, the guideline was discussed with an ICT expert who did not take part in the interview.

4.3.1.5 Conducting Interviews in the First Iteration of the "Evaluating" Phase

As in the qualitative data collection of the "Theorising" phase (cf. subsection 4.1.2.5), again the following five aspects according to Easterby-Smith et al. (2012) were judged as important to consider for the interview conducting:

- Obtaining trust
- Social interaction
- Using the appropriate language
- The location of the interview
- Recording interviews

For the experts participating repeatedly, obtaining trust and social interaction was potentially easier. For the new experts, the same principles as in the interviews of the first iteration of the "Theorising" phase (cf. subsection 4.1.2.5) were applied. All the different integral parts of the model (metamodel, procedure reference model, component models, input documents, documentation) were available as printouts throughout the interview. Unclear terms were clarified when necessary. The interviews were again mostly conducted in meeting rooms provided by the experts in their working environment, one interview was conducted in a public space chosen by the expert. The interviews were recorded digitally, specific indications about the illustration were captured as sketches or drafts on the printout.

4.3.1.6 Transcribing in the First Iteration of the "Evaluating" Phase

Like in the second iteration of the "Theorising" phase (cf. 4.1.4.6), the following transcription procedure based on Kuckartz (2010, p. 52) was chosen:

- Choice of transcription type
- Definition of transcription rules
- Proofreading of transcripts and ensuring anonymization

adding – as the model as an artefact was in the centre of the investigation – the step

- Decision about included objects/artefacts

Para-verbal inputs like breaks between words, voice intonations etc. (Dresing, et al., 2015; Kowal & O'Connell, 2015; Kuckartz, 2010) were again not the focus of the analysis. As the interviews were recorded, record-based but focusing on the question about model evaluation summarised transcripts according to Dresing (2015), Kuckartz (2010) and Mayring (2016) were electronically captured in order to be able to import them in the analysis tool. As the situation about the transcription and translation was again the same as described in subsection 4.1.2.6, accordingly the defined transcription rules as well as the procedure about proofreading and anonymization were adopted. In terms of the included model as an artefact, all the sketched inputs were verbalized and included as text in the transcripts.

Appendix 18 shows an extract of an example of an anonymized interview transcript of one qualitative interview in the "Evaluating" phase.

4.3.1.7 Data Analysis in the First Iteration of the "Evaluating" Phase

The goal of the first iteration of the "Evaluating" phase was to validate the model by assessing the design objectives. As the guideline was set up in an a priori research-driven approach (cf. subsection 4.3.1.3), the category system and the coding started with an a priori, research-driven thematic code development, according to Bernard et al. (2017), Boyatzis (1998) and Kuckartz (2018), however developing the category system and data classification in an iterative manner and thus extending the initial system in a deductive-inductive hybrid approach according to Bernard et al. (2017), Boyatzis (1998) and Flick (2016).

The categories of the first iteration of the "Evaluating" phase were, as described in subsection 4.3.1.2 and listed in detail in Appendix 19:

- Clarity / understandability
- Structure / readability
- Notation
- Consistency
- Extendibility
- Realistic / relevance
- Completeness
- Reduced to the max

- Documentation

As in the second iteration of the “Theorising” phase, the classification approach of content structuring within qualitative context analysis according to Mayring (2010) was chosen, illustrated in Figure 35. The different steps included the following specific activities:

1st step – Determining of entities of analysis:
All the eight conducted interview transcripts (cf. sample in subsection 4.3.1.1) were chosen for the analysis.

2nd step – Theory-driven definition of content-related main categories and 3rd step – Determining of the specification (theory-driven) compilation of the category system:
Due to the fact that the interview guideline was already set up according to a theory-driven categorization (cf. subsection 4.3.1.2) and according to the relevant dimensions of comparison by Kelle and Kluge (2010), steps 2 and 3 could be merged.
The content-related categories are listed in Appendix 19.

4th step – Formulation of definitions, anchor examples and coding rules for the individual categories:
Step 4 could be treated in a reduced manner focusing on the content and not on the coordination between different coders, as the whole coding was done by the author.

5th step – Material processing: coding of found information:
The coding itself was conducted with the help of the coding and analysis software MAXQDA. The applied codes are displayed in Appendix 20.

6th step – Material processing: Treatment and extraction of coded information:
The coded information was extracted to individual Excel tables for every artefact, assigning them to the following classifications:

- Indicated Corrections
- Mentioned Improvements
- Mentioned “Nice to haves”

The corresponding material processing is displayed in Appendix 21.

7th step – Revision: if necessary review of category system and category definitions:
Due to the fact that the categories had already been very specifically set up and that the generated data was not vast, no revision of the category system became necessary.

8th step – Paraphrasing of extracted material:
The paraphrasing of the data was done with the goal of re-modelling in mind, thus in note form instead of fully formulated sentences.

9th step – Summary per category
The summary per category was done in order to document the relevant content from the first iteration of the “Evaluating” phase to involve in the re-modelling and is listed in detail in subsection 4.2.3.1.

10th step – Summary per main category:

As the procedure of coding was already conducted in a summarising manner, no further summarisation was necessary.

4.3.1.8 Reporting and Interpretation of the Findings of the First Iteration of the "Evaluating" Phase

The goal of the first iteration of the "Evaluating" phase was to evaluate the design objectives of the procedure reference model. The material was clustered in tables (cf. Appendix 21) as a basis for a transparent formulation of the following re-modelling, structured by the different artefacts (metamodel, procedure reference model, component models, documentation), completed by an overall model context validation.

According to the interviewed experts, the extendibility of the model, the adequacy of the modelling language as well as the reduction to the most essential aspects were clearly given. Mostly given, according to their indications, were the intuitive access of the graphical representation, the clear structure and the consistency within the model. Concerning the consistency with the real world, it became clear that principally this would be given according to the interviewed experts, however currently the illustrated context seems not to be proceeded within practice. It also became apparent that the idea of an underlying metamodel is seen as theoretically necessary by the experts, however not being the first priority in practice.

The contribution of the interviewed experts revealed that the relevance, the extendibility of the model, the adequacy of the modelling language, the consistency within the model, the focus on the most important aspects, the completeness and the consistency both within the model and with the metamodel were clearly given. Again, the consistency with the real world was seen as ambiguous by some experts: A procedure according to the proposed model would be appreciated, however it currently doesn't seem to be state of the art in practice. What the interviewed experts indicated as having to be improved in the model was the description of the model scope and its specific application.

In terms of the component models, the interviewed experts saw the adequacy of the modelling language, the extendibility of the model, the consistency with the real-world, the relevance and the consistency and completeness according to the metamodel as given. The interviewed experts evaluated the intuitive understanding of the graphical representation, the clear structure and good readability, the consistency with the metamodel and within the model as well as the focus on the most important aspects within the model as mostly given.

In terms of the documentation, the interviewed experts clearly evaluate the adequacy of Microsoft Visio in the context as given. However, the precision and justification of the documentation were not yet seen as completely given by the interviewed experts.

The adequacy of using Microsoft Excel for the input documents was seen as clearly given. The clear structure and the completeness were seen as partially given.

In addition to the specifically asked questions, the interviewed experts made overall indications about the design objectives:

- Consistent colours in the model, the Excel sheets and the documentation should be introduced, keeping in mind black and white printouts.

- The combination of the model with the documentation seems good and necessary.
- The model should also be applicable for small contexts by enabling the summarising of steps.

4.3.1.9 Critical Reflections of the Qualitative Research Undertaken in the First Iteration of the "Evaluating" Phase

The critical reflection is conducted based on the quality criteria framework by Gerber et al. (2018). As outlined in section 3.4, firstly integrity and trustworthiness and secondly the contextual rigour demonstrated in this iteration will be discussed.

4.3.1.10 Critical Reflection on Integrity and Trustworthiness in the First Iteration of the "Evaluating" Phase

The critical reflection about the integrity and trustworthiness in this iteration turned out to be identical with the critical reflection in the second iteration of the "Theorising" phase (subsection 4.1.2.9.1).

4.3.1.11 Critical Reflection on Contextual Rigour in the First Iteration of the "Evaluating" Phase

The sampling strategy and participation of this iteration can be summarised as shown in Table 23.

Table 23: Summary of sampling strategy and participation in the first iteration of the "Evaluating" phase

Method	Popu-lation	Sampling	Effective sample size	Hospital profile	Participant profile/ Function
Semi-structured expert interviews (QUAL)	216 hospi-tals	non-probability, purposive heterogeneous sampling by people (hospital ICT staff/managers concerned with non-medical applications and/or hospital ICT architecture)	Total of 8 experts		
			1	General hospitals, Centrum care (Level 1, University Hospitals)	ICT
			4	General hospitals, Centrum care (Level 2)	ICT
			1	Primary care (Level 4)	ICT
			1	Psychiatric clinics (Level 2)	ICT
			1	Rehabilitation clinics and Special clinics (Surgery, Gynaecology/Neonatology, Paediatrics, Geriatrics, Diverse)	ICT

For testing the quality of the sample, the same evaluation criteria as in the qualitative interviews of the "Theorising" phase were applied. Unfortunately, the number of at least 12 participants as suggested by Saunders et al. (2016, p. 297) for a heterogeneous population could not be reached – even though numerous experts within the population were contacted, only eight experts were available and willing to participate at the time. However, the sufficient variety of the sampling according to Boyatzis (1998) can be seen as mostly given, as the four categories centrum care, primary care, psychiatric clinics and rehab/special clinics (cf. subsection 2.1.2.5.2) could be covered, backed by the fact that the experts again partially represented more than one hospital (sub-)unit. In addition, as in the interviews in the second iteration of the "Theorising" phase, a certain saturation of the answers according to Kelle and Kluge (2010) could be recognized, also indicating that the size of the sample was adequate. It has to be mentioned however that not all experts as representatives of their field of action – managers of non-medical ICT or applications in hospitals – according to Flick (2016) had the same knowledge about all the applied modelling methods and notations. In this iteration, the interviews were digitally recorded after having received the consent of the participants to do so. Still, as a summarising transcription was done translating the German answers of the experts into English for the documentation of the thesis, again a heuristic reduction of the answers needed for the remodelling and a smoothing of the interviews occurred according to Kuckartz (2010) and Mayring (2016) by translating. The quality of the data collection was therefore potentially influenced. The other quality aspects for qualitative data collection already described in subsection 4.1.2.9 also applied for this interview iteration (pre-testing of the interview guideline, capability of researcher to capture complex context in reduced time, balancing act between openness in order to capture different aspects and structuring with regard to scope and future analysis, risk of influencing, absence of personally sensitive or privately critical questions and conscious deception, compensation of method disadvantage, intersubjective transparency, indication, balancing confidentiality, comfort and trust) and can again be assessed as given.

As the interviews were again completely coded and analysed by one researcher, divergence of data handling was, on one hand, once again minimized according to Lamnek (1995) and Mayer (2009). On the other hand, inter-coder reliability according to Mayring (2010) and Kuckartz (2010) could not be assured. As the theory-driven codes were already in a research pragmatic range according to Lamnek (2010) and Kluge (1999), a reduction and simplification of dimensions wasn't necessary this time.

With the explicit documentation, explanation and reasoning of the conducted research steps and procedures, the intersubjective transparency and indication according to McLeod (2011), Steinke (1999), Saunders et al. (2016) and Yardly (2015) was again ensured. The methods to analyse the data can be assessed as pragmatic and adequate for the context and the findings generated in this first iteration of the "Evaluating" phase can again be declared as empirically anchored according to Steinke (1999) and thus fit as a basis for the second iteration of the "Building" phase.

4.3.1.12 Chapter Summary of the First Iteration of the "Evaluating" Phase

The goal of the first iteration of the "Evaluating" phase was to validate the design objectives including the aspects of (formal) correctness, systematic design, clarity, comparability, construction adequacy and language adequacy. In order to reach this goal, problem-centred, semi-structured, face-to-face expert interviews with hospital ICT staff/managers concerned with non-medical applications/ICT architecture were conducted with a non-probability, purposive heterogeneous sampling approach. As a conceptual basis, the multi-perspective framework for evaluating reference models by Frank (2007a) was chosen. The eight conducted and recorded interviews were transcribed, categorized and coded.

Generally speaking, the design objectives of the chosen modelling tools and languages, the included aspects, the relevance of the context and the extendibility of the model could be classified as given according to the interviewed experts. Several minor adjustments enhancing the intuitive access, the understandability, the consistency and the understandability by the future target group in practice in all the different integral parts of the procedure reference models could be determined as inputs for the second iteration of the "Building" phase (cf. subsection 4.2.3).

In Figure 53, the qualitative research conducted in the first iteration of the "Evaluating" phase is shown within the overall research design.

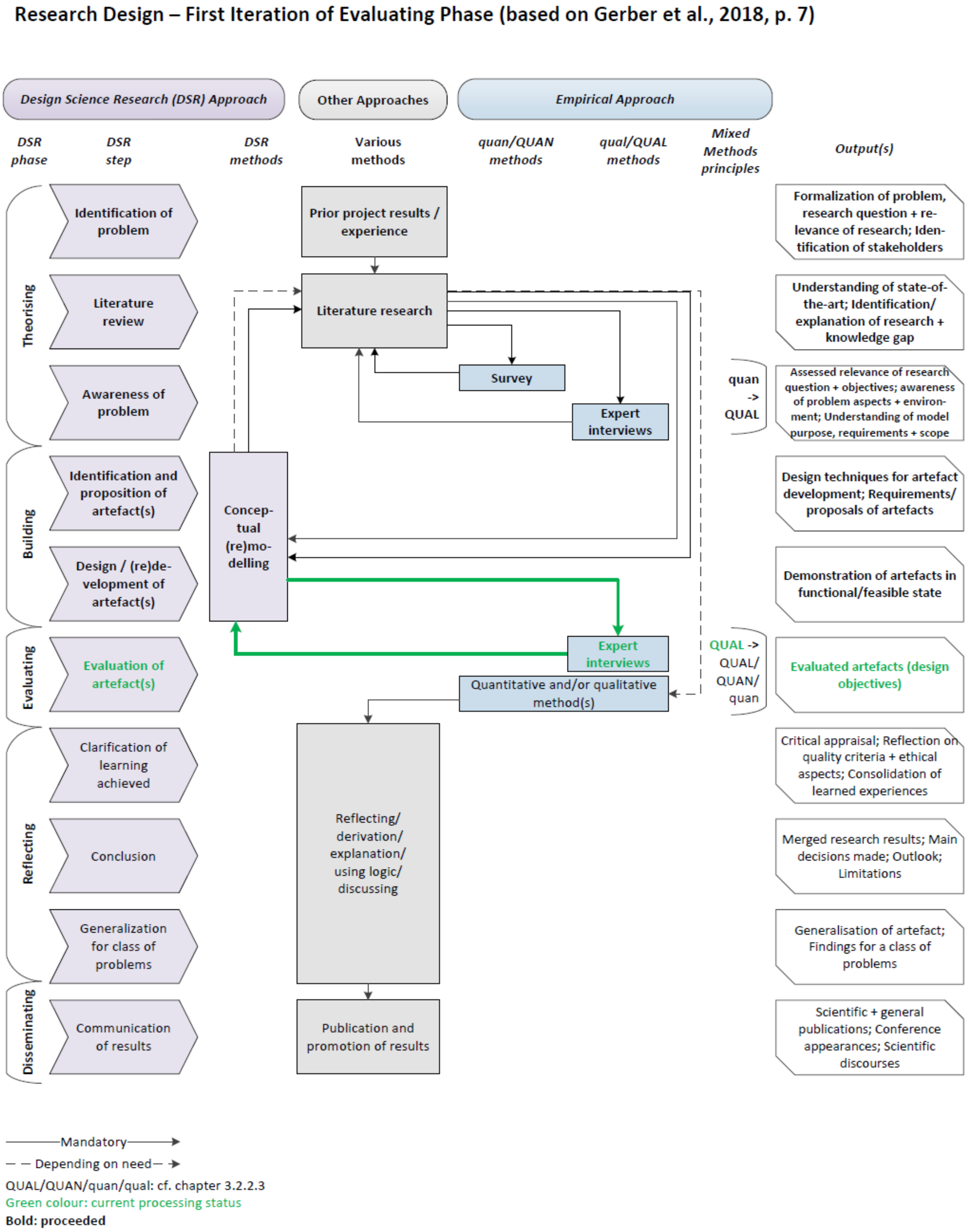

Figure 53: Illustration of the qualitative research in the first iteration of the "Evaluating" phase within the overall research design

4.3.2 Research Conducted in the Second Iteration of the "Evaluating" Phase

In this subsection, the research conducted in the second iteration of the "Evaluating" phase is presented. In this iteration, the goal was to validate the epistemic objectives (cf. subsection 1.3.2.1) including, as listed in Appendix 15, aspects concerning organisational mindset, communication, knowledge, need for training, maintenance, change and cost-benefit in connection with the procedure reference model. In order to reach this goal, focus group discussions according to Krueger and Casey (2009), Morgan (1988), Stewart et al. (2011) and Chiarini Tremblay et al. (2010) were chosen as the method. As the focus group discussions were conducted in the context of the underlying Design Science Research principles, the "Focus Group Steps for "Artifact Refinement and Evaluation in Design Research" suggested by Chiarini Tremblay et al. (2010) were chosen as the sensitising concept, including the steps "formulation of research objective", "identification for sample frame", "identification of moderator", "development", "pre-test of questioning route", "recruitment of participants", "conduct of focus group discussions", adding – as in the data collection in the second iteration of the "Theorising" phase as well as in the first iteration of the "Evaluating" phase – the aspects of "transcribing" and "critical reflection" as illustrated in Figure 54.

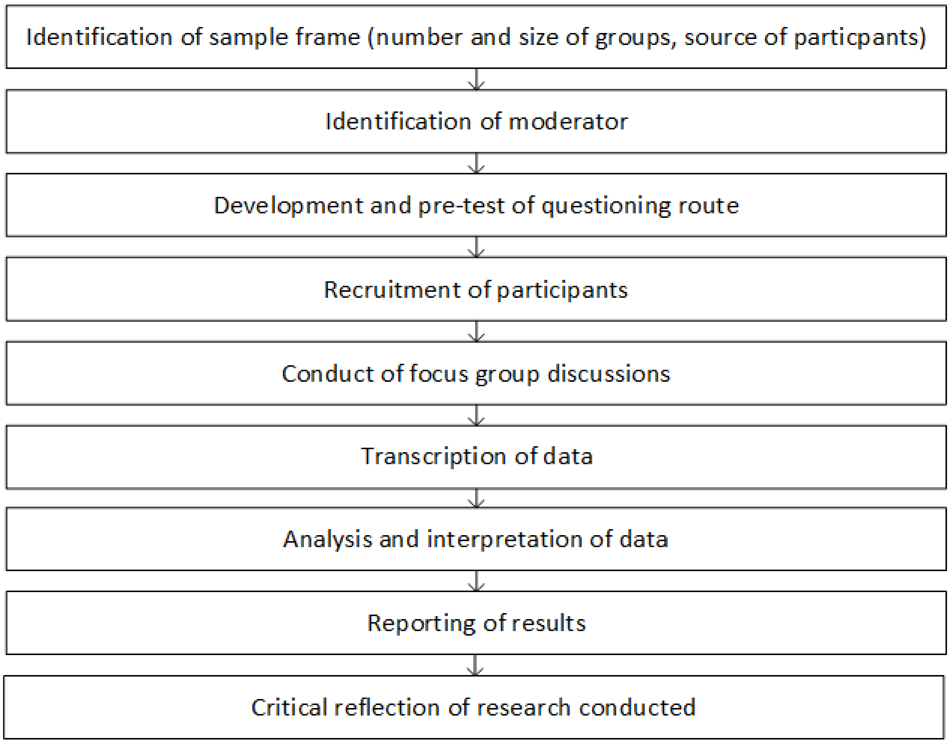

Figure 54: Data collection steps in focus group discussions applied in the second iteration of the "Evaluating" phase adapted from Chiarini Tremblay et al. 2010

The steps will be discussed in detail in the following subsections.

4.3.2.1 Identification of Sample Frame

As stated above, the goal of the second iteration of the "Evaluating" phase was to validate the procedure reference model by evaluating the epistemic objectives in focus group discussions. In order to represent the hospital industry and thus have a high potential for generalization according to Flick (2016), out of the 216 German-speaking hospitals in Switzerland (cf. subsection 4.1.2.1), again a non-probability, purposive heterogeneous population approach according to Saunders et al. (2016) was chosen, trying to include as many hospital categories according to Federal Office of Public Health (BAG Bundesamt für Gesundheit, 2018) (cf. subsection 2.1.2.5.2) in the sample as possible, with the goal to reflect the complexity of the industry (Flick, 2016). Again it was sampled by people according to Boyatzis (1998). However, in this iteration, in addition to the experts representing hospital ICT staff/managers concerned with non-medical applications and/or hospital

ICT architecture, also managers involved in controlling and KPI reporting in the same hospital as well as managers of non-medical support services working with non-medical support service KPI reporting in the same hospital, all representing their specific professionalization according to Flick (2016), were targeted as the sample.

4.3.2.2 Identification of Moderator

The background and skills necessary to conduct focus group discussions according to Stewart et al. (2011) was assessed to be suitable in the person of the author in order to be selected as a moderator. As the author had been intensely involved in the content as well as the hospital context and was already experienced in conducting workshops and moderating group discussions, the moderator preparation according to Gibson and Arnott (2007) and Stewart et al. (2011) was judged to be adequate. However, as additional preparation, literature on moderator tactics and styles in focus group discussions (Braun & Clarke, 2013; Chiarini Tremblay, et al., 2010; Stewart, et al., 2011) was consulted.

4.3.2.3 Development and Pre-Test of Questioning Route

The context of the discussions had already been prepared by choosing the multi-perspective framework for evaluating reference models by Frank (2007a) for the “Evaluating” phase. After having assessed the design objectives in the previous iteration (cf. subsection 4.3.1), now the part of the epistemic aspects was the focus of validation in this iteration. By proceeding in this manner, again a mostly theory-driven semi-structured interview guideline was set up, including mainly theory-driven questions according to Flick (2016). The basis for the formulation of questions is listed in detail in Appendices 7 – 10. For the formulation, choice and structuring of the questions, the specific circumstances of focus group discussions according to Stewart et al. (2011) were kept in mind. The interview guideline was pre-tested by challenging the understandability of the questions and the logic of the setup by a non-expert in the field. The guideline is displayed in a compact manner in Appendix 22.

4.3.2.4 Recruitment of Participants

The intention was to find at least three focus groups in different hospital categories with at least one ICT staff/manager concerned with non-medical applications and/or hospital ICT architecture, one manager involved in controlling or KPI reporting and/or one manager of non-medical support services in the same hospital. Principally, all the 216 German speaking hospitals in Switzerland (cf. subsection 4.1.2.1) were the population for the sampling. However, it turned out that it was very difficult to find the intended experts for this validation iteration willing to take the necessary time for preparation and ready to challenge the model content with colleagues. Finally, it was possible to recruit four focus groups from four different hospital categories. In all focus groups, one ICT staff member or manager concerned with non-medical applications and/or hospital ICT architecture was present. However, the remaining groups were composed differently, including controllers, reporting managers, other ICT managers and/or non-medical support service application users – some participants were brought along without having been announced in advance, some announced participants failed to appear due to individual reasons.

4.3.2.5 Conduct of Focus Group Discussions

Three focus group discussions were conducted in meeting rooms provided by the experts in their working environment, one was held virtually via WebEx. The setup of the physical arrangement of the discussion was therefore mainly influenced by the local context. The focus group discussions were recorded digitally after receipt of the corresponding consent by all participants. For the conduct of the focus group discussions, the following steps according to Braun and Clarke (2013), Chiarini Tremblay et al. (2010), Morgan (1988), Stewart et al. (2011) and Wilson (2014) were proceeded with:

- Summarising the research context, the research goal and the previously conducted steps
- Introducing ground rules and setup of discussion
- Beginning the discussion and the recording
- Ensuring participation
- Ensuring time management
- Concluding the discussion and ending the recording
- Debriefing

4.3.2.6 Transcription of Data

Like in previous settings (cf. 4.1.2.6 + 4.3.1.6), the following transcription procedure based on Kuckartz (2010, p. 52) was chosen:

- Choice of transcription type
- Definition of transcription rules
- Proofreading of transcripts and ensuring anonymization

As in the first iteration of the “Evaluating” phase, para-verbal inputs like breaks between words, voice intonations etc. (Dresing, et al., 2015; Kowal & O'Connell, 2015; Kuckartz, 2010) were again not the focus of the analysis, but the specific content. As the interviews were recorded, record-based but focusing on the question about model evaluation summarised transcripts according to Dresing (2015), Kuckartz (2010) and Mayring (2016) were electronically captured with the goal to import them into the analysis tool.

As again only the author was involved in the transcription as well as the translation and as no para-verbal context needed to be registered, the transcript rules according to Dresing et al. (2015), Kuckartz (2010) and Ludwig-Mayerhofer (1999) could be kept short and were defined as follows:

- The question posed by the interviewer was copied from the interview guideline and marked in bold, prefixed with an “NG” as abbreviation of the interviewer’s name.
- The answers from the discussion partners were registered subsequently.
- For the anonymized indication of the person giving an answer or statement, the anonymized function or department was prefixed. If several people of the same department/function were present, they were differentiated by adding numbers.
- Between the answer and the next question from the guideline, an empty line was introduced.
- While proofreading the transcripts, further anonymization and a correct translation into English was checked.

Appendix 23 shows an example extract of an anonymized transcript of one of the focus group discussions in the “Evaluating” phase.

During this procedure, a deeper understanding of what was said and a familiarization with the data according to Wilson (2014) took place preparing for the next steps, the coding, analysis and concluding.

4.3.2.7 Analysis and Interpretation of Data in the Second Iteration of the "Evaluating" Phase

The goal of the analysis and interpretation of the second iteration of the "Evaluating" phase was to conclude the evaluation by completing the validation assessing the epistemic objectives.

As the guideline was again set up in an a priori research-driven approach (cf. subsection 4.3.2.3), the coding as well started with an a priori, research-driven thematic code development according to Bernard et al. (2017), Boyatzis (1998) and Kuckartz (2018), however allowing the development of the category system and data classification in an iterative manner and thus extending the initial system in a deductive-inductive hybrid approach according to Bernard et al. (2017), Boyatzis (1998) and Flick (2016). For this purpose, as in previous iterations, the classification approach of content structuring within qualitative context analysis according to Mayring (2010) was chosen, illustrated in Figure 35.

The different steps of the content structuring framework of Mayring (2010) included the following specific activities:

1st step – Determining of entities of analysis:
All the four conducted focus group transcripts were chosen for the analysis.

2nd step – Theory-driven definition of content-related main categories and 3rd step – Determining of the specification (theory-driven) compilation of the category system:
Due to the fact that the interview guideline was already set up according to a theory-driven categorization (cf. subsection 4.3.2.3) and according to the relevant dimensions of comparison by Kelle and Kluge (2010), steps 2 and 3 could be merged. The content-related categories are listed in detail in Appendix 24.

4th step – Formulation of definitions, anchor examples and coding rules for the individual categories:
Step 4 could be treated in a reduced manner focusing on the content and not on the coordination between different coders, as the whole coding was once again done by the author.

5th step – Material processing: coding of found information:
The coding itself was conducted with the help of the coding and analysis software MAXQDA. The applied codes are displayed in Appendix 25.

6th step – Material processing: treatment and extraction of coded information:
The coded information was extracted to individual Excel tables for every cluster of questions, assigning them to the following classifications:

- Decision-making support
- Contribution
- Benefit
- Cost-benefit relationship
- Influence of model development context

- Other applications/aspects

The corresponding material processing is displayed in Appendix 26.

7th step – Revision: if necessary review of category system and category definitions:
Due to the fact that the categories had already been very specifically set up and that the generated data was not vast, again no revision of the category system became necessary.

8th step – Paraphrasing of extracted material:
The data was, as in the first iteration of the "Evaluating" phase, paraphrased within the lists of the Excel files.

9th step – Summary per category:
The summary per category was done in order to reach the final formulation of the validation.

10th step – Summary per main category:
As the procedure of coding was already conducted in a summarising manner, no further summarisation was necessary.

4.3.2.8 Reporting of Results

The goal of the interpretation of the findings of the second iteration of the "Evaluating" phase was to conclude with the validation of the model. As in the first iteration of the "Evaluating" phase, the material was clustered in tables (cf. Appendix 26) as a basis for a transparent formulation of the following validation.

In terms of decision-making support, the contributions of the focus group discussion participants revealed that the value of the procedure reference model is mainly seen in the application alignment – the decision-making support for the KPI implementation and the reporting form was discussed with controversy. Here, apparently another different procedure dealing with the question about the appropriate KPIs would have to be developed as a separate pre-step before applying the procedure reference model concerned with the involved applications. The discussions also showed that the procedure reference model is perceived to be suitable for a more structured stakeholder management and for a more transparent decision-making process.

In terms of contribution of the procedure reference model, the focus group participants expressed that they assess the procedure reference model as contributory to customer-orientation, internal and external communication, knowledge management as well as cost reduction in processes. Again, the structured basis and the potential for more transparency by applying the model were seen as major aspects. However, the discussions also showed that the experts are critical about finding and assigning suitable people to apply the procedure reference model and are unsure if the prevailing organisational culture would embrace the application of the procedure reference model.

Another aspect to be validated was the overall cost-benefit relationship. When asked about the effort-benefit-relationship of the application of the procedure reference model overall, the focus group participants mainly estimated that the benefit would be higher than the effort. However, some considered that in the beginning, the initiation effort would be higher but then be compensated after a while. Nevertheless, within the sub-questions, the inputs of the focus group participants showed a broad range of estimations: While some saw no need for strategic or organisational adaptation, others estimated a moderate need. In terms of training, it was mostly seen to have little need in the circle of the focus group participants, however high need for other stakeholders, if they were to be involved in the model application. In terms of model adaptation, different opinions were expressed as well: While some participants would simply take over the model as it is, some saw potential adaptation needs within their context. In terms of model maintenance, most participants estimated that for serious maintenance of the content, a moderate need would be necessary.

When asked about the greatest benefit of the procedure reference model, the participants mainly mentioned

- stakeholder management support/stakeholder involvement
- more structured application handling
- more transparency with applications and KPIs
- the structured and consistent approach
- the possibility to adjust the model

Asked if how the procedure reference model had been developed (as a PhD thesis) would influence the application and/or the acceptance, the participants expressed no negative but rather positive influence.

In terms of other applications or aspects of the procedure reference model, the focus group participants mentioned the advantage of the systematic, encompassing, transparent, iterative, pragmatic procedure as a basis for collaboration, it was however also mentioned once again that the model moderator should be chosen wisely and that a glossary and a connection to strategic KPI selection should be considered.

4.3.2.9 Critical Reflection of the Qualitative Research Undertaken in the Second Iteration of the "Evaluating" Phase

The critical reflection is conducted based on the quality criteria framework by Gerber et al. (2018). As outlined in section 3.4, firstly integrity and trustworthiness and secondly the contextual rigour demonstrated in this iteration will be discussed.

4.3.2.9.1 Critical Reflection on Integrity and Trustworthiness in the First Iteration of the "Evaluating" Phase

The critical reflection about the integrity and trustworthiness in this iteration turned out to be mostly identical with the critical reflection in the second iteration of the "Theorising" phase (subsection 4.1.2.9.1). What had to be handled differently in this iteration was the group moderation which was necessary because more than one expert was present. A challenge was the attempt of the moderator to balance out influential factors and to manage group dynamics according to Braun and Clarke (2013), Morgan (1988) and Stewart et al. (2011). Even though moderator preparation took place following Gibson and Arnott (2007) and Stewart et al. (2011), it was not always possible to involve all the participants approximately equally in the discussions, particularly when higher ranked participants with strong opinions were present together with more quiet subordinates.

4.3.2.9.2 Critical Reflection on Contextual Rigour in the First Iteration of the "Evaluating" Phase

The sampling strategy and participation of this iteration can be summarised as shown in Table 24.

Table 24: Summary of sampling strategy and participation in the second iteration of the "Evaluating" phase

Method	Popu-lation	Sampling	Effective sample size	Hospital profile	Participant profile/ Function
Focus group discus-sions (QUAL)	216 hospi-tals	non-probability, purposive heterogeneous sampling by people (hospital staff/managers concerned with non-medical applications and/or hospital ICT architecture and/or KPIs from Controlling/Reporting and/or non-medical support services subject-areas	Total of 4 focus groups, 13 individiuals		
			1	General hospitals, Centrum care (Level 1, University Hospitals)	ICT, Reporting, Controlling, Controlling, Space Management
			1	Primary care (Level 4)	ICT, Controlling, Reporting
			1	Psychiatric clinics (Level 2)	ICT, ICT, ICT
			1	Rehabilitation clinics and Special clinics (Surgery, Gynaecology/Neonatology, Paediatrics, Geriatrics, Diverse)	ICT, Controlling

There is no consistent definition in literature about the minimal number of focus group participants nor the number of discussions, but instead the saturation of answers as an indication of an adequate number is suggested by Braun and Clarke (2013), Kelle and Kluge (2010) and Krueger (2009). While the sufficient variety of the sampling according to Boyatzis (1998) can be seen as given, as the four categories centrum care, primary care, psychiatric clinics and rehab/special clinics were represented (cf. subsection 2.1.2.5.2), saturation could not be reached in all the questions, partially also because it turned out that not all the focus group discussion participants were equally skilled to answer the questions. On the other hand, confronting people other than the ICT experts with the model for the first time in the research process, it clearly showed that the target group of the model are ICT staff in healthcare and that within the hospitals, a cross-disciplinary dialogue even in the non-medical areas doesn't seem to be widely established yet.

In this iteration, the interviews were again digitally recorded after having received the consent to do so. Still, as a summarising transcription was done translating the German answers of the experts into English for the documentation of the thesis, the quality of the data was potentially influenced by the translation. In addition, the heuristic reduction of the answers needed for a summarised validation led to a smoothing of the interviews according to Kuckartz (2010) and Mayring (2016), also potentially influencing the quality of data. The other quality aspects for qualitative data collection already described in subsection 4.1.2.9 (pre-testing of the interview guideline, capability of researcher to capture complex context in reduced time, balancing act between openness in order to capture different aspects and structuring with regard to scope and future analysis, risk of influencing, absence of personally sensitive or privately critical questions and conscious deception, compensation of method disadvantage, intersubjective transparency, indication, balancing confidentiality, comfort and trust) also applied for this interview iteration and can again be assessed as given. The critical reflection about other aspects concerning coding, analysing and documenting turned out to be identical as in the first iteration of the "Theorising" phase (cf. subsection 4.1.2.9.2).

With this second iteration of the "Evaluating" phase, the research was decided to be concluded, moving to the final reporting and the formulation of conclusions.

4.3.2.10 Chapter Summary of the Second Iteration of the "Evaluating" Phase

In the second iteration of the "Evaluating" phase, the goal was to validate the epistemic objectives including aspects concerning organisational mindset, communication, knowledge, need for training, maintenance, change and cost-benefit in connection with the procedure reference model. In order to reach this goal, focus group discussions were chosen for data collection. As conceptual bases, the Artifact Refinement and Evaluation in Design Research by Chiarini Tremblay et al. (2010) and the multi-perspective framework for evaluating reference models by Frank (2007a) were chosen. Four focus groups in four different hospital categories could be conducted. Based on the assessments of the focus group discussion participants, the model can be validated as follows:

- The main decision support of the procedure reference model can be seen within the application alignment rather than for the decision support of KPI introductions or new reporting forms.
- The procedure reference model is seen as suitable for a more structured stakeholder management and as an enabler for a more transparent decision-making process.
- The procedure reference model is mostly seen as contributory to customer-orientation, internal and external communication, knowledge management as well as cost reduction in processes.
- The structured basis and the potential for more transparency by applying the model were seen as major potentials offered by the procedure reference model.
- When applying the procedure reference model seriously, the need for its maintenance is seen as medium.
- The application of the procedure reference model is seen to lead to a favourable cost-benefit relationship overall.
- The stakeholder management support and stakeholder involvement, the more structured application handling, the increased transparency with applications and KPIs, the structured, consistent, encompassing, pragmatic approach and the possibility to adjust the model were declared as the greatest benefits of the procedure reference model by the focus group participants.
- However, the discussions revealed that the people applying the procedure reference model must be chosen wisely and the organisational culture must be kept in mind when applying the model.
- As an extension to the procedure reference model, the aspect of how to choose appropriate KPIs could be considered as a future add-on.

In Figure 55, the qualitative research conducted in the second iteration of the "Evaluating" phase is shown within the overall research design.

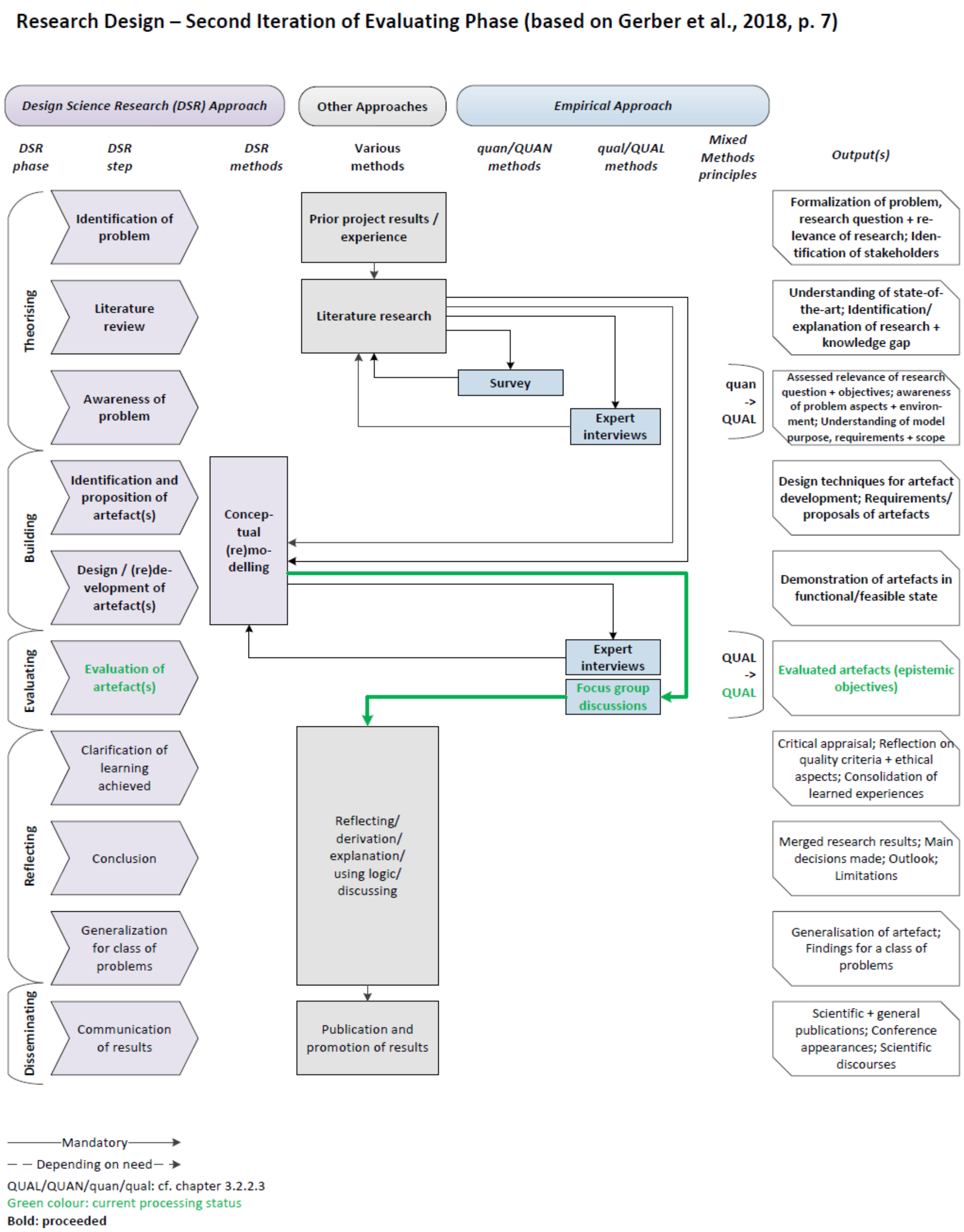

Figure 55: Illustration of the qualitative research in the second iteration of the “Evaluating” phase within the overall research design

4.3.3 Summary of the “Evaluating” Phase

The goal of the “Evaluating” phase according to Gerber et al. (2018) (cf. Figure 19) was to validate the procedure reference model in two iterations. In the first iteration, the design objectives were evaluated by eight experts leading to corrections and adaptations of the model (cf. second iteration of the “Building” phase, subsection 4.2.3). In the second iteration of the “Evaluating” phase, the epistemic objectives were evaluated in four focus group discussions. The result of the “Evaluating” phase is a validated procedure reference model.

5 Conclusions, Discussions and Outlook

This chapter includes the conclusions, critical reflections and limitations of the research conducted and findings as well as recommendations and an outlook about the developed research output. Figure 56 shows chapter 5 in the context of the whole thesis.

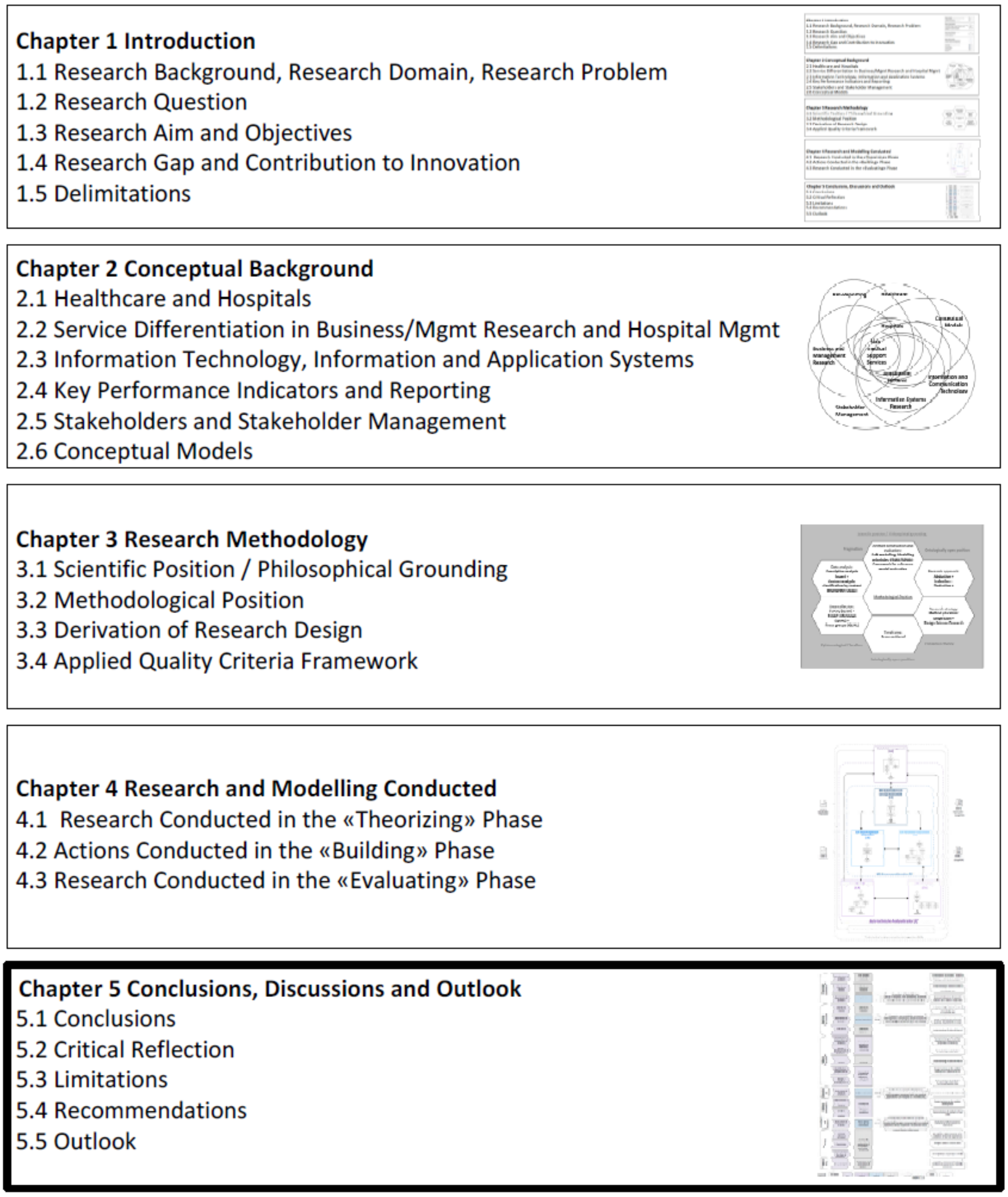

Figure 56: Context of chapter 5 within the whole thesis

5.1 Conclusions

In this thesis, a procedure reference model for the alignment of non-medical support service applications in hospitals was developed as a framework for ensuring the correct reporting and configuration of key performance indicators.

The development of the model was done based on a pragmatic philosophical grounding in a multi-methodological iterative approach, including Design Science Research (DSR) principles for the modelling actions and mixed methods principles for the empirical research. The development of the model was conducted in the three phases “Theorising”, “Building” and “Evaluating”. In the “Theorising” phase, a sequential mixed methods approach combining a quantitative survey with qualitative expert interviews was chosen. In the two iterations of the “Building” phase, the modelling and re-modelling actions were conducted while in the “Evaluating” phase, the model was validated in two iterations based on expert interviews and focus group discussions.

The presented procedure reference model consists of

- six component models
- the metamodel
- two input documents
- a documentation for application

All artefacts are explained in detail in subsections 4.2.3.8 - 4.2.3.12.
The evaluation of the model revealed that the developed procedure reference model is seen as

- supporting decisions about application alignment
- suitable for a more structured stakeholder management and an enabler for more transparent decision-making processes
- contributory to customer-orientation, internal and external communication, knowledge management as well as cost reduction in processes and potentially a favourable cost-benefit relationship in the long-term.

As the main advantages of the procedure reference model, the following aspects were determined in the “Evaluating” phase:

- the support for stakeholder management and stakeholder involvement
- the potential for more structured application handling
- the possibility for increased transparency with applications and KPIs
- the structured, consistent, encompassing, pragmatic approach suggested by the model
- the possibility to adjust the model.

As major challenges, the following aspects were discovered throughout the “Evaluating” phase:

- the people applying the procedure reference model should have the necessary personal and professional expertise and competences and should thus be chosen wisely
- the organisational culture must be kept in mind when applying the model

By developing the procedure reference model, the research question could be answered and the research aims and objectives could be reached (cf. sections 0 and 1.3). Based on the systematic assessment of quality criteria throughout the whole research process (cf. critical reflection subsections in every iteration) as well as overall in section 5.2, both the research process and the research output can be assessed as credible and contributory. The comparison of the developed output compared to the conceptual background didn’t reveal any significant inconsistences. The application of the model can potentially have implications for hospital organisation management practice and healthcare provision in general; for the scientific community implications were found to be in the methodological context (details cf. subsection 5.1.4).

5.1.1 Conclusions about Answering the Research Question and Reaching the Research Aims and Objectives

The research question of this thesis was “What is the procedure and its significant aspects for aligning non-medical-support service applications in hospitals so that relevant key performance indicators for a systematic controlling and optimization can be generated and configured as effectively and efficiently as possible?”.

In terms of “procedure”, the research has led to the identification of two iterations with three sub-processes in each iteration:
The first iteration is the “KPI Assessment Iteration” with the sub-processes

- KPI Stakeholder Involvement Assessment
- KPI Parameter Assessment
- KPI Reporting Need Assessment

The second iteration is the “Socio-technical Analysis Iteration” with the sub-processes

- Stakeholder Management
- KPI Reporting Implementation Analysis
- Application Alignment Analysis

The iterations and sub-processes are explained in detail in subsections 4.2.3.8 - 4.2.3.12.

In terms of “significant aspects”, the research has revealed that the model

- has to provide the possibility to assess and deal with every non-medical support subject-area individually
- has to allow to be adapted, depending on the maturity levels of the ICT and/or hospital management and/or overall hospital culture
- has to clearly focus on stakeholder management and stakeholder involvement rather than on technical aspects
- should encompass a vast list of potential stakeholders to be considered
- should have a favourable cost-benefit relationship and should be well understandable in order to ensure manageability and acceptance
- should include the idea of iterations
- should explicitly include the aspect of documentation.

Detailed information can be found in subsection 4.1.2.10.

By systematically developing and validating the procedure reference model for the alignment of non-medical support service applications in hospitals, the research aim of this thesis – to develop a reference model providing the necessary information about a standardized procedure and its significant aspects for aligning non-medical support service applications in hospitals so that relevant key performance indicators for systematic controlling and optimization can be generated and configured as a decision basis for managers – could be reached.

The corresponding research objectives of this thesis were defined as to develop a relevant and economically efficient artefact which is (formally) correct, has a systematic design, is clear and comparable and has an adequate construction. The evaluation in two separate iterations showed that the developed procedure reference model is relevant, is seen to be – when applied in certain conditions – economically efficient, is judged to be formally correct and clear, having a systematic design and an adequate construction;

comparability turned out not to be a significant aspect in this context (details cf. subsection 4.3.1.8). Due to these findings, the research objectives can be assessed as reached.

5.1.2 Conclusion about Quality Criteria of the Research Process and the Research Output

For the conclusion about the quality criteria of the research process and the research output, the quality criteria framework of Gerber et al. (2018) already applied throughout the whole research process is used as a basis once again, assessing the main criteria of credibility and contribution.

5.1.2.1 Conclusion about Credibility of the Research Process and the Research Output

According to Gerber et al. (2018), a conclusion about the credibility can be drawn by assessing the integrity and trustworthiness of the researcher and the contextual rigour of the research.

To reach credibility within this thesis, quality criteria were systematically followed and explicitly formulated from the beginning and throughout the whole process. The sensibility of method pluralism was outlined in detail in chapter 3. Ethical considerations were specifically made transparent and discussed in detail in every empirical research iteration throughout the whole thesis. By doing so, the author has explicitly sought to demonstrate integrity and trustworthiness.

In order to reach contextual rigour, firstly existing theories and frameworks were applied and explained throughout the whole research and modelling process. Secondly, the research methods were chosen in accordance with an overall research design framework, refined based on the course of research. As a multi-method research approach was applied, quality aspects of rigour in the quantitative, the qualitative and the DSR context had to be considered. While the quality aspects in the qualitative research and the DSR context in the modelling could clearly be demonstrated, rigour in the quantitative context was weak. However putting it into the context of the whole research design and overall process, the reduced quantitative rigour can be seen as being compensated by the rigour of the other contexts.

The degree of credibility of the research conducted in this thesis can thus be assessed as high.

5.1.2.2 Conclusion about Contribution of the Research Process and the Research Output

In order to conclude about the degree of contribution of the research process and the research output, Gerber et al. (2018) suggest assessing the relevance of the research question, the presented (generalizable) problem solving and the innovation as well as the degree of accessibility and transparency, fitness to the target group and reduction of the academia-practice gap.

The relevance of the research question was assumed based on previously conducted research projects by the author and by literature research. This assumption was confirmed not only by a first conducted research iteration specifically investigating this aspect (cf. subsection 4.1.1), but throughout the whole research process.

The interpretations of the research in the “Evaluating” phase show that the relevance of the research question as well as the research output is given for the context of ICT in German-speaking Swiss hospitals.

Due to the fact that the experts and focus group discussion participants estimated the developed procedure reference model as supportive, suitable and contributory in different perspectives (details cf. subsection 4.3.2.8), the relevance of the model as a problem solving tool in the context of German-speaking Swiss hospitals can be seen as given.

Assessing the originality and innovation of the research output as well as the research process based on the different indications suggested by Phillips and Pugh (2015, p. 75), originality can be determined in at least two aspects:

- The thesis presents empirical work not having been done before by investigating the non-medical support service applications in hospitals in terms of a systematic procedure for alignment.
- The thesis systematically applies DSR principles combined with empirical mixed methods in the context of healthcare in a novel manner.

The degree of transparency can be assessed as very high, as all the different assumptions, procedures and critical reflections have intentionally been revealed throughout the whole thesis. The degree of accessibility of the research and research result in terms of obtainability is also very high as the thesis will officially be published and after that, all the model artefacts will be published online both in English and German and thus freely available. In addition, after the thesis publication, appearances in conferences as well as publications in journals are planned, ensuring further access. The assessment of the degree of accessibility of the research and research results in terms of understandability has to be differentiated: Within the thesis, the academic community is the target group and a scientific language style is appropriate which might not be intuitively accessible for practice. Therefore, the language style of the documentation of the procedure reference model as a research output was chosen differently. The accessibility of the documentation for application was evaluated in the first iteration of the “Evaluating” phase and can be assessed as given. This fact also leads to the conclusion that both the degree of fitness of the research output for the target group (ICT staff member or manager concerned with non-medical applications and/or hospital ICT architecture) as well as the reduction of the academia-practice gap can be assessed as high.

It can thus be determined that the thesis contributes

- to handling some of the numerous challenges of the current structural changes in healthcare by offering a model as a tool
- to knowledge by filling research gaps
- methodologically by further developing the DSR approach suitable for complex environments and for multi-disciplinary environments.

The degree of contribution of both the research process as well as the research output developed in this thesis can be seen as high.

5.1.3 Conclusion of Output Compared to Conceptual Background

Where the findings of the thesis can be compared with existing literature, no significant inconsistences can be reported. In terms of the healthcare and hospital content, the inputs given by the experts involved throughout the research process correspond with the challenges and trends in (Swiss) healthcare and hospital ICT investigated and described in literature. In terms of the application of DSR in healthcare, documentation has been scarce as discussed in subsection 2.3.5.3. In Management Research, DSR has so far also only marginally been mentioned (Hanhart, 2008; Rosenkranz, et al., 2007). A comparison is therefore not indicated; however, it can be referred to the identified contributions in the previous and the implications in the following subsection.

5.1.4 Conclusion about Implications

The conclusion about the implications is divided into the perspective of practice and the perspective of the scientific community.

For practice, the research output can be assessed as

- providing a systematic basis for communication between different non-medical support service application stakeholders and thus
- enabling managers responsible for the non-medical support services and/or applications in this area and
- contributing to the development of a more effective healthcare provision and thus

potentially enabling a better sustainability in hospitals.

The author hopes that in a long-term perspective, the developed procedure reference model as well as the initiated discussions with the experts can contribute to a sustainable development of healthcare and particularly hospital management by:

- improving data transparency and interdisciplinarity,
- enabling synergy effects between different disciplines,
- helping to optimise the effectiveness and efficiency of the non-medical support processes and the IT application management,
- reducing waste of resources,
- reducing cost in non-medical support and IT services in healthcare by reducing interfaces, complexity, risk, support and lifecycle management,
- raising quality,
- and thus improving health of humans overall.

The implications for the scientific community can mainly be seen in the methodological context. The thesis provides an example for a systematically conducted multi-methodological approach combining mixed methods principles for the empirical research and DSR principles for the modelling actions. It would be interesting to see other research projects conducted in a similar process in order to have the possibility to compare approaches and also to discuss further developments. In addition, existing frameworks could be considered to be adjusted based on their application in this thesis.

5.2 Critical Reflection

In this section the answering of the research question, the achieving of the research aim and objectives, the fit of the scientific position together with the applied research methodology, the research process and the research outcome are critically reflected.

5.2.1 Critical Reflection on Answering the Research Question and Reaching the Research Aims/Objectives

Before having defined this thesis' research question, aims and objectives, a deep involvement in the context of the thesis had taken place. By the specific formulation of the research question, aim and objectives, a balance was sought between the possibility of developing the output in an innovative manner, however formulating a certain guidance. The answering of the research question as well as reaching the research aims and objectives did not pose significant problems as such.

5.2.2 Critical Reflection on the Fit of the Scientific Position and the Applied Research Methodology

The definition of the scientific position of philosophical grounding including the basic belief, ontology, epistemology, concept of truth and axiology and the methodological position including the research approach, the research strategy and the research timeframe were the result of very intensive literature research. In order to have a solid foundation, overarching research philosophical literature was consulted as well as specific research done in the context of conceptual modelling and within the DSR approach. However, following the controversial debates between the different representatives within and between the different paradigms - and particularly within the context of the young approach of DSR - was confusing in the beginning. The personal discourse with other researchers as well as previous research experience with a corresponding knowledge about the personal scientific grounding helped in finding the bearings in the vast area of research philosophical discussions and discourses.

Following the broad understanding in literature that pragmatism offers a philosophically and methodologically middle position for applied research not only for a mixed/multiple method research design but particularly for DSR (which itself is seen as suitable for Mode 2 Business and Management Research, cf. subsections 2.2.1 and 2.3.5.2), the chosen scientific position and the applied research methodology can be seen to fit. A deeper discourse about research philosophical aspects was not the goal of this thesis conducted in an applied research context. A further discussion with more research theoretical representatives would however be interesting (cf. subsection 5.4.2).

5.2.3 Critical Reflection on the Chosen Research Design

Like the definition of the scientific position, the development of the research design was done after a very intensive literature research as well. It deliberately tried to balance the need for complying with existing criteria about the definition of good research design while at the same time trying to prove creativity and use independent approaches.

As outlined in subsection 3.2.2.3, the degree of suitability and quality of mixed and multi-method approaches can be evaluated and assessed differently. The fact that the research design of this thesis is not only mixed in the sense of empirical research but additionally mixed with DSR principles adds another level of critical reflection. Starting with the critical reflection on empirical mixed methods, it must be said that initially, it was intended to conduct another quantitative validation iteration with the goal to not only reach good quality criteria degrees in the quantitative context (validity, reliability, objectivity), but also to reach a good balance between quantitative and qualitative empirical methods. However, it turned out that assessing a specific model requires a certain understanding and potentially evokes the need for explanation. This led to the assessment that a quantitative method would not be an expedient validation method in this context. The intended truly balanced empirical mixed methods approach could therefore not be delivered within this context – the quantitative part of the research design has to be declared as minimal. However, starting with a quantitative survey in order to verify the relevance of the research followed by a qualitative expert interview iteration in a sequential way turned out to be a suitable manner for the “Theorising” phase generating the basis for the modelling. This approach provided the possibility to learn quickly for the subsequent iteration, it enabled the management of separate approaches, it provided a possibility to gain access to experts and potential disadvantages of every method could partially be compensated. Applying two different qualitative methods in the “Evaluating” phase adds to the method pluralism at least within the qualitative paradigm.

5.2.4 Critical Reflection on Samples

The sample strategy and the samples are critically reflected on in every iteration. However, as in all the research, some kind of expertise of the participating members was sought, the term “expert” is critically reflected. In literature, the definition of “experts” is discussed with controversy (Bogner & Menz, 2005; Gläser & Laudel, 2009; Liebold & Trinczek, 2009; Meuser & Nagel, 2009). In this thesis, particularly in the “Evaluating” phase, the degree of expertise of the participating sample diverged considerably. While this can be seen as an enrichment particularly in the focus group discussions, it can also be judged as being critical in the expert interview concerned with the design objectives (cf. subsection 4.3.1). However, the limited availability of the sample reduced the scope of expert choice (cf. section 5.3) leading to the fact that it was not possible to involve completely different experts for the different iterations. The limited expert choice also must be mentioned in respect to the participating members in the focus groups where not all the agreed participants turned up in the end or other people were brought along, not allowing us to present a consistent sample profile of all focus group discussions.

5.2.5 Critical Reflection on Research Process Overall

Based on the overall research design presented in Figure 24, the course of research and development is presented throughout chapter 4. The fact that the chosen research design allowed iterations and the fact that the effectively conducted course of research was iterative might cause difficulties in following the process. Therefore, the research process is also presented in a sequential manner in Figure 57. Compared to the iterative research process illustrations, this figure additionally includes information on the sample as well as the research output.

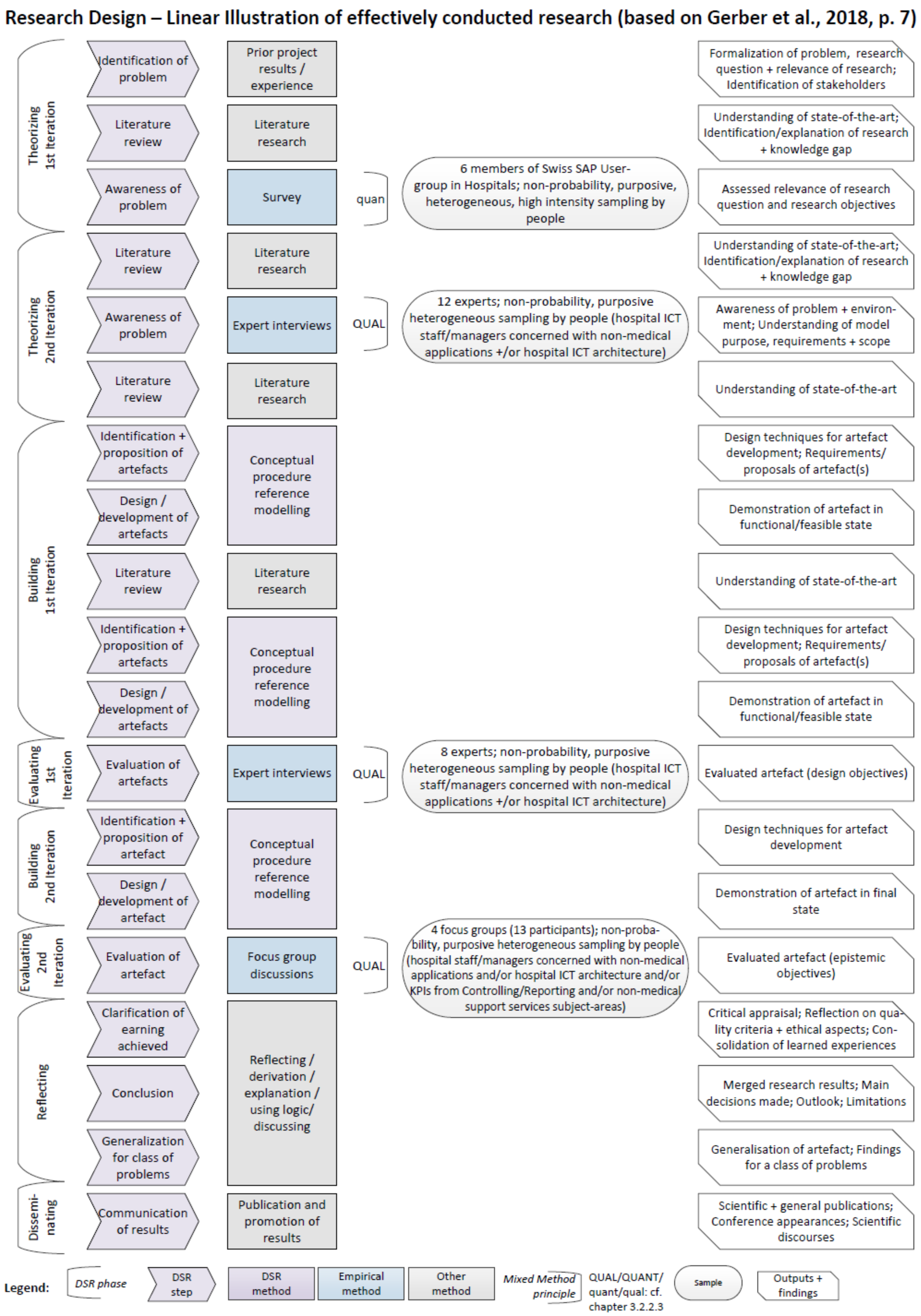

Figure 57: Sequential illustration of research process

Concerning the overall research process with an underlying multi-methodological approach, it can be said that even with a founded know-how about empirical mixed methods as well as DSR principles, the endeavour to follow a method pluralistic approach turned out to be challenging in many different ways. In terms of transparency of the applied methods, a lot of background information is required in order to ensure the common understanding of every paradigm and chosen context. This fact can be seen as a threat. Depending on their background, it might be overstraining for some people while creating the impression to be too shallow in certain aspects for others. This could potentially lower the degree of accessibility and thus the quality criterion of communication (cf. subsection 5.1.2.2). Furthermore, in-depth know-how not only of the different research methods but also about the impact of combining them is necessary. For the author, this led to an increased potential of insecurities particularly because the confrontation with specific questions revealed a big range of opinions. However, this circumstance offered a great chance for the author to form her own opinions and to learn more on how to deal with dissonances. Overall, it can be said that all the different methods require different competencies and interests – to combine them all in one person seems to be a noble objective. In the future, the author will preferably conduct method-pluralistic research projects together with research colleagues, having the chance to amalgamate the different competencies and knowledge in a research team.

5.2.6 Critical Reflection on Research Outcome

The research output has already been critically reflected throughout the iterations of the "Building" and the "Evaluating" phase as well as in subsection 5.1.2. One has to keep in mind that if the model is supposed to be applied in practice, additional communication and support measures as well as additional research and development projects have to be initiated beyond this thesis bearing in mind that the procedure reference model will most likely not be successfully applicable if the top management in hospitals doesn't understand the importance of the ICT and the support service context (cf. chapter 5.4.1).

5.3 Limitations

The individual quality criteria and implications of methods have to be discussed in their specific context as done throughout chapters 4 and 5. In terms of the overall research project, the following limitations have to be mentioned:

- Initially, the sample size per iteration was planned to be larger. Even though a great effort was made to identify and motivate further participants in all iterations, this turned out to be harder than expected. However, considering the impact of the current structural change of the healthcare sector on the targeted population (cf. subsection 2.1.2.3), dealing with more urgent daily business seems like a logical consequence.
- The generalisation of the research result is limited, as only German-speaking hospitals in Switzerland could be included in the different samples.
- The English version of the research outputs necessary for the documentation of this thesis could not be validated with a corresponding sample in English-speaking countries within this context.

5.4 Recommendations

In this section, recommendations for practice and the scientific community are outlined, including suggestions for action planning and potential next steps.

5.4.1 Recommendations for Practice

The attention about the need for the alignment of non-medical support service applications in hospitals as well as the availability of the freely available procedure reference model as a systematic tool has to be drawn to hospital (top) managers. This can be done by

- contacting interested parties directly to transfer the information (e. g. the participating experts within this thesis)
- collaborating with hospital ICT communities (e. g. ICT in healthcare focus groups) using their communication channels both in writing as well as in person
- publishing practice-oriented articles in magazines read by hospital managers
- presenting during hospital organization management conferences and fairs, being present in person and online on the event website
- collaborating with political healthcare organizations publishing a corresponding whitepaper
- cooperating with consultancies specializing in healthcare ICT to offer guidance with the implementation of the procedure reference model in the specific context
- convincing healthcare politicians to formulate political proposals about healthcare ICT

Managers in hospitals (in general or in the ICT context) interested in applying the procedure reference model in their organisation are advised to identify the appropriate person to entrust with the application of the model. For a potentially successful application of the model, the person entrusted with this task should

- work with applications and/or software architecture within the hospital ICT,
- understand the principle of how to apply models,
- have stakeholder management know-how and experience,
- know how to edit Microsoft Excel files and
- officially be given the responsibility and the accordingly necessary resources and competences in order to proceed.

The recommended steps for the people entrusted with the project of introducing the procedure reference model are:

- familiarisation with the context by reading the documentation (cf. Appendix 10) and sifting the two input documents; further indications about this step are described in the documentation
- starting with one specific context and/or stakeholder
- adapting the documents to the internal context if necessary
- proceeding iteratively until the intended alignment can be done; further indications about this procedure are described in the documentation
- adding new areas to be aligned and starting with a new iteration

In addition, the author recommends the exchange of the lived experience in peer-to-peer networks.

As the application landscape is subject to evolution and as the involved stakeholders and their roles change, the application of the procedure reference model has – after the completion of the introduction project – to be included in the continual service improvement (CSI) measures of the day-to-day operations of the ICT service provision including, according to Ebel (2015), assessments, benchmarking, scorecards and the Deming Cycle (Plan, Do, Check, Act).

Whoever decides on the application of the procedure reference model should be aware that on one hand, this might contribute to

- the development of a culture of more fact-oriented, iterative, error-friendly decisions instead of emotional, hierarchical one-person-decisions,
- the breaking of silo-thinking and the enablement of systematic inter-/cross-disciplinary dialogues,
- the improvement of explicit stakeholder management,
- a more holistic view, encompassing all aspects contributing to a patient-centred service provision and
- iterative learning and knowledge management,

but on the other hand can also

- provoke resistance as a reaction to change,
- be time-intensive, if stakeholder management leads to further professional or personal discussions and
- evoke the need for (philosophical) discussions about balancing human and technological aspects.

5.4.2 Recommendations for Scientific Community

The research design chosen in this thesis was deliberately thought of as a contribution to the development of DSR in the context of information systems and business administration. The combination of different methods and the iterative procedure revealed several advantages and challenges (cf. subsections 5.1.2.2 and 5.2.5). It would be valuable if other research projects were conducted in this iterative, multi-methodological DSR approach to exchange experience and findings in terms of the design and procedure and subsequently (collaboratively) further develop the approach. In addition, the impact of this development in a research philosophical perspective would be interesting to be discussed with researchers representing different paradigms. In addition, since the application, adaptations and adjustments of different frameworks throughout the whole research project were described in detail, some of those frameworks could be considered to be updated. As an example, the framework “Mixed methods research designs with emphasis on design research process” presented by Huysmans and Verelst (2012, p. 116) could be complemented by adding the sequential evaluative approach (cf. Table 12).

5.5 Outlook

Digitalisation in general and in healthcare in particular will most likely occupy humankind in the next few years all over the world. This will encompass many different aspects, including how to handle software applications necessary for fulfilling the service provision in healthcare organisations. If the procedure reference model developed throughout this thesis is applied in practice, it can potentially contribute to this development – however small that part might be.

For the procedure reference model, the following future developments could be interesting:

- It would be an advantage, if the model were available in French and Italian, so the model could be applied and validated all across Switzerland and not only in the German-speaking part.
- After an in-depth application of the model in several contexts (and potentially also in other countries), the model could be re-evaluated and adjusted based on the practical experience and gained practical insights. Then, empirical validation could potentially be done with a higher degree of validity, reliability and objectivity.

- If enough institutions would apply the model, it could also be considered to adjust the model to different aspects like e. g. type of organisation, size or maturity of organisational culture.
- The model could also be implemented as a programmed tool including the possibilities to link different aspects dynamically and to directly jump between documents/contexts; this measure would however potentially reduce the possibility to easily implement individual adjustments.
- Another possibility would be to examine, to what extent the procedure reference model could also be applied for the alignment of medical applications or even software applied in healthcare organisations in general and what adjustments would be necessary if done so.

It could also be interesting to add the aspect of measuring the efficiency of ICT departments or healthcare organisations in general before and after the application of the model. This however would require a long-term timeframe as well as a broad setup considering direct and indirect cause and effect relationships.

Next to the procedure reference model itself, a new model dealing with the choice of the important KPIs for healthcare organisations mentioned by several representatives of the hospital finance departments in the focus group discussions could also be a valuable add-on, however requiring a completely new perspective and involving different stakeholders and thus triggering a new research project.

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Appendix 1 – Translation of Questionnaire Applied in The First Iteration of the "Theorising" Phase – Visible Part for Participants

Please note: As the survey was conducted in the German-speaking part of Switzerland, the original survey questionnaire was applied in German (for the discussion of translation issues cf. section 3.4).

Introduction for online survey questionnaire

This survey intends to get clarification on how to develop an ideal display of interrelations and characteristics of non-medical support services in hospitals in terms of software applications as a basis for a more transparent software architecture management in the hospital industry.

The survey is voluntary, anonymous with no possibility to track your information and you can stop your participation at any time.

Shoud you have any questions, you can contact me at any time.
Nicole Gerber

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To start the questionnaire, please click [here: Button]

Questionnaire of online survey
Have you conducted application integrations measures during the past 5 years or have planned to do so in the area of:
1. Logistics
☐ Procurement yes/no/no information, not known
☐ Warehousing yes/no/no information, not known
☐ Transport & Provision yes/no/no information, not known
☐ Disposal & Recycling yes/no/no information, not known

2. Infrastructure
☐ Maintenance yes/no/no information, not known
☐ Space Management yes/no/no information, not known
☐ Energy yes/no/no information, not known

3. Facility Services
☐ Safety & Security yes/no/no information, not known
☐ Cleaning yes/no/no information, not known
☐ Sterilization yes/no/no information, not known

4. Hospitality
☐ Catering yes/no/no information, not known
☐ Textiles yes/no/no information, not known
☐ Operation of accommodation & Operation of properties yes/no/no information, not known
☐ Hotel Services Diverse yes/no/no information, not known

Concerning applications in the area of xy [to be generated automatically for all indications with yes above]:

Which integration mechanisms of the application integration was conducted or is planned in the area of xy?
EAI
☐ File Transfer [Explanation if necessary as pop-up: One application writes a file that another later reads. The applications need to agree on the filename and location, the format of the file, the timing of when it will be written and read, and who will delete the file.]
☐ Shared Database [Explanation if necessary as pop-up: Multiple applications share the same database schema, located in a single physical database. Because there is no duplicate data storage, no data has to be transferred from one application to the other]

☐ Remote Procedure [Explanation if necessary as pop-up: One application exposes some of its functionality so that it can be accessed remotely by other applications as a remote procedure. The communication occurs real-time and synchronously.]
☐ Messaging [Explanation if necessary as pop-up: One applications publishes a message to a common message channel. Other applications can read the message from the channel at a later time. The applications must agree on a channel as well as the format of the message. The communication is asynchronous.]
☐ SOA
☐ Web Services
☐ Other integration mechanisms, namely:
☐ No information / not know
Remarks:

On which integration layer was the application integration in the area of xy conducted or is planned?
☐ Connectivity - [Explanation if necessary as pop-up: The connectivity-layer plays a role in interfacing with source systems in order to retrieve the data.]
☐ Transportation - [Explanation if necessary as pop-up: After the data has been retrieved, the transportation-layer takes care in transferring the data to the centralized integration infrastructure.]
☐ Translation - [Explanation if necessary as pop-up: The translation-layer then translates the data to the format of the target application.]
☐ Process Automation – [Explanation if necessary as pop-up: The process-automation layer supports routing to the target systems and executes events.]
☐ Other integration layer, namely:
☐ No information / not known
Remarks:

Which form of solution was applied or is planned?
☐ Integrated product
☐ Toolkit application
☐ Other form of solution, namely
☐ No information / not known
Remarks:

Which degree of integration (coupling) was chosen or is planned?
☐ tight coupling
☐ loose coupling
☐ No information / not known
Remarks:

Which target applications was chosen or is planned?
☐ Standard application/purchased software
☐ Customer specific application/in-house development
☐ No information / not known
Remarks:

Thank you very much for your participation!

Appendix 2 – Translation of Questionnaire Applied in the First Iteration of the "Theorising" Phase – All Programmed Selection Options

Please note: As the survey was conducted in the German-speaking part of Switzerland, the original survey questionnaire was applied in German (for the discussion of translation issues cf. section 3.4).

Application integration in hospitals

1. Select the areas where you have performed or planned application integration actions in the recent 5 years *

☐ Procurement (Logistics)
☐ Storage Management (Logistics)
☐ Transport & Fleet Management (Logistics)
☐ Disposal & Recycling (Logistics)
☐ Maintenance (Infrastructure)
Space management (Infrastructure)
Energy (Infrastructure)
Safety & Security (Facility Services)
Cleaning (Facility Services)
Sterilization (Facility Services)
Catering (Hotel Services)
Textiles (Hotel Services)
Operation of accommodation & Operation of properties (Hotel Services)
Hotel Services Div. (Hotel Services)

2. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the procurement field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

3. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the storage management field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

4. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the transport & fleet management field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

5. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the disposal & recycling field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

6. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the maintenance field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

7. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the space management field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

8. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the energy field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

9. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the safety & security field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

10. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the cleaning field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

11. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the sterilization field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

12. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the catering field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

13. Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the textiles field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA

Web Services
No information/unbeknownst
Other integration mechanism, namely:

14.	Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the operation of accommodation & operation of properties field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
Web Services
No information/unbeknownst
Other integration mechanism, namely:

15.	Which Enterprise Application Integration Mechanism (EAI) was performed respectively planned for the hotel services div. field? *

File Transfer
Shared Database
Remote Procedure
Messaging
SOA
☐ Web Services
☐ No information/unbeknownst
☐ Other integration mechanism, namely:

16.	Which was the Integration Layer where the application integration / EAI for the field of procurement had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely:

17.	Which was the Integration Layer where the application integration / EAI for the field of storage management had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely:

18.	Which was the Integration Layer where the application integration / EAI for the field of transport & fleet management had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst

☐ Other Integration layer, namely: ______

19. Which was the Integration Layer where the application integration / EAI for the field of disposal & recycling had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely: ______

20. Which was the Integration Layer where the application integration / EAI for the field of maintenance had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely: ______

21. Which was the Integration Layer where the application integration / EAI for the field of space management had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely: ______

22. Which was the Integration Layer where the application integration / EAI for the field of energy had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely: ______

23. Which was the Integration Layer where the application integration / EAI for the field of safety & security had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely: ______

24. Which was the Integration Layer where the application integration / EAI for the field of cleaning had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely:

25. Which was the Integration Layer where the application integration / EAI for the field of sterilization had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely:

26. Which was the Integration Layer where the application integration / EAI for the field of catering had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely:

27. Which was the Integration Layer where the application integration / EAI for the field of textiles had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely:

28. Which was the Integration Layer where the application integration / EAI for the field of operation of accommodation & operation of properties had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst
☐ Other Integration layer, namely:

29. Which was the Integration Layer where the application integration / EAI for the field of hotel services div. had taken place respectively is planned? *

☐ Connectivity
☐ Transportation
☐ Translation
☐ Process Automation
☐ No information/unbeknownst

☐ Other Integration layer, namely:

30. Which form of solution was thereby selected respectively planned for the field of procurement? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

31. Which form of solution was thereby selected respectively planned for the field of storage management? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

32. Which form of solution was thereby selected respectively planned for the field of transport & fleet management? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

33. Which form of solution was thereby selected respectively planned for the field of disposal & recycling? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

34. Which form of solution was thereby selected respectively planned for the field of maintenance? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

35. Which form of solution was thereby selected respectively planned for the field of space management? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

36. Which form of solution was thereby selected respectively planned for the field of energy? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

37.	Which form of solution was thereby selected respectively planned for the field of safety & security? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

38.	Which form of solution was thereby selected respectively planned for the field of cleaning? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

39.	Which form of solution was thereby selected respectively planned for the field of sterilization? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

40.	Which form of solution was thereby selected respectively planned for the field of catering? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

41.	Which form of solution was thereby selected respectively planned for the field of textiles? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

42.	Which form of solution was thereby selected respectively planned for the field of operation of accommodation & operation of properties? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

43.	Which form of solution was thereby selected respectively planned for the field of hotel services div.? *

☐ Integrated product
☐ Toolkit application
☐ No information/unbeknownst
☐ Other form of solution, namely:

44.	Which degree of integration (coupling) has been chosen or planned for the field of procurement? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

45. Which degree of integration (coupling) has been chosen or planned for the field of storage management? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

46. Which degree of integration (coupling) has been chosen or planned for the field of transport & fleet management? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

47. Which degree of integration (coupling) has been chosen or planned for the field of disposal & recycling? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

48. Which degree of integration (coupling) has been chosen or planned for the field of maintenance? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

49. Which degree of integration (coupling) has been chosen or planned for the field of space management? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

50. Which degree of integration (coupling) has been chosen or planned for the field of energy? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

51. Which degree of integration (coupling) has been chosen or planned for the field of safety & security? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

52. Which degree of integration (coupling) has been chosen or planned for the field of cleaning? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

53. Which degree of integration (coupling) has been chosen or planned for the field of sterilization? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

54. Which degree of integration (coupling) has been chosen or planned for the field of catering? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

55. Which degree of integration (coupling) has been chosen or planned for the field of textiles? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

56. Which degree of integration (coupling) has been chosen or planned for the field of accommodation & operation of properties? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

57. Which degree of integration (coupling) has been chosen or planned for the field of hotel services div.? *

☐ Tight coupling
☐ Loose coupling
☐ No information/unbeknownst
☐ Comments:

58. Which target applications have been chosen or planned for the field of procurement? *

☐ Standard application/Purchased software

☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

59. Which target applications have been chosen or planned for the field of storage management? *

☐ Standard application/Purchased software
☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

60. Which target applications have been chosen or planned for the field of transport & fleet management? *

☐ Standard application/Purchased software
☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

61. Which target applications have been chosen or planned for the field of disposal & recycling? *

☐ Standard application/Purchased software
☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

62. Which target applications have been chosen or planned for the field of maintenance? *

☐ Standard application/Purchased software
☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

63. Which target applications have been chosen or planned for the field of space management? *

☐ Standard application/Purchased software
☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

64. Which target applications have been chosen or planned for the field of energy? *

☐ Standard application/Purchased software
☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

65. Which target applications have been chosen or planned for the field of safety & security? *

☐ Standard application/Purchased software
☐ Customer specific application/In-house development
☐ No information/unbeknownst
☐ Comments:

66. Which target applications have been chosen or planned for the field of cleaning? *

- ☐ Standard application/Purchased software
- ☐ Customer specific application/In-house development
- ☐ No information/unbeknownst
- ☐ Comments:

67. Which target applications have been chosen or planned for the field of sterilization? *

- ☐ Standard application/Purchased software
- ☐ Customer specific application/In-house development
- ☐ No information/unbeknownst
- ☐ Comments:

68. Which target applications have been chosen or planned for the field of catering? *

- ☐ Standard application/Purchased software
- ☐ Customer specific application/In-house development
- ☐ No information/unbeknownst
- ☐ Comments:

69. Which target applications have been chosen or planned for the field of textiles? *

- ☐ Standard application/Purchased software
- ☐ Customer specific application/In-house development
- ☐ No information/unbeknownst
- ☐ Comments:

70. Which target applications have been chosen or planned for the field of accommodation & operation of properties? *

- ☐ Standard application/Purchased software
- ☐ Customer specific application/In-house development
- ☐ No information/unbeknownst
- ☐ Comments:

71. Which target applications have been chosen or planned for the field of hotels services div.? *

- ☐ Standard application/Purchased software
- ☐ Customer specific application/In-house development
- ☐ No information/unbeknownst
- ☐ Comments:

Appendix 3 – Example of Quantitative Results of Question 1 out of 71 in Survey Questionnaire in the “Theorising” Phase

Please note: As the survey was conducted in German, the results are only available in German – however, the documentation of the results presented in subsection 4.1.1.7 were translated (for the discussion of translation issues cf. section 3.4).

1. Wählen Sie die Bereiche, bei denen Sie innerhalb der letzten 5 Jahre Applikationsintegrationsmassnahmen durchgeführt haben oder planen, dies zu tun.

Häufigkeitstabelle

Item	Teilnehmer	Beschaffung (Logistik)	Lagerbewirtschaftung (Logistik)	Transportleistungen & Bereitstellung (Logistik)	Entsorgung & Recycling (Logistik)	Instandhaltung (Infrastruktur)	Flächenmanagement (Infrastruktur)	Energie (Infrastruktur)	Safety & Security (Facility Services)	Reinigung (Facility Services)	Sterilisation (Facility Services)	Verpflegung (Hotellerie)	Textilien (Hotellerie)	Unterkunftsverwaltung & Betrieb Liegenschaften (Hotellerie)	Hotellerie Divers (Hotellerie)
Wählen Sie die Bereiche, bei denen Sie innerhalb der letzten 5 Jahre Applikationsintegrationsmassnahmen durchgeführt haben oder planen, dies zu tun.	6	83.33 %	83.33 %	33.33 %	0.00 %	66.67 %	50.00 %	0.00 %	16.67 %	33.33 %	33.33 %	50.00 %	33.33 %	50.00 %	16.67 %

Kodierungstabelle

Item		Beschaffung (Logistik)	Lagerbewirtschaftung (Logistik)	Transportleistungen & Bereitstellung (Logistik)	Entsorgung & Recycling (Logistik)	Instandhaltung (Infrastruktur)	Flächenmanagement (Infrastruktur)	Energie (Infrastruktur)	Safety & Security (Facility Services)	Reinigung (Facility Services)	Sterilisation (Facility Services)	Verpflegung (Hotellerie)	Textilien (Hotellerie)	Unterkunftsverwaltung & Betrieb Liegenschaften (Hotellerie)	Hotellerie Divers (Hotellerie)
Wählen Sie die Bereiche, bei denen Sie innerhalb der letzten 5 Jahre Applikationsintegrationsmassnahmen durchgeführt haben oder planen, dies zu tun.	Kodierung:	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Statistiktabelle

Item	RangeMin	RangeMax	Mittelwert	Standardabweichung	Varianz
Wählen Sie die Bereiche, bei denen Sie innerhalb der letzten 5 Jahre Applikationsintegrationsmassnahmen durchgeführt haben oder planen, dies zu tun.	1	14	6.52	4.44	19.70

Appendix 4 – Translation of Interview Guideline in the Second Iteration of the "Theorising" Phase

Please note: As the interviews were conducted in the German-speaking part of Switzerland, the original guideline was therefore applied in German (for the discussion of translation issues cf. section 3.4).

Questionnaire / Interview Guideline
Thank you very much for your time and your willingness to participate.

To start with: the title of my Research Study is "Development of a reference model with the interrelations and specific characteristics of non-medical support services (FM) in hospitals including the corresponding impact on the software architecture". So the goal of this interview is to receive expert knowledge about how a reference model with the focus on interrelations of non-medical support services in hospitals has to be developed, including the impacts on the software architecture.

You have received all the administrative information by e-mail. Do you have any question concerning this?

The interview will include questions including the aspects of the PESTEL analysis (Political, Economic, Social, Technological, Ecological, Legal aspects). But to start with:

Could you please quickly describe the IT organisation in your hospital so I can get a general understanding?

How high would you assess the degree of integration of your IT infrastructure in your hospital and what are your reasons for this assessment?

How high would you assess the IT maturity in your hospital ans what are your reasons for this assessment?

As previous projects have shown, the applications of non-medical support services are currently often not well aligned on the software architecture and therefore, Managers of FM in Healthcare (comprising Logistics, Infrastructure, Safety & Security and Hospitality, see appendix *[-> http://pd.zhaw.ch/publikation/upload/210956.pdf]* **often don't receive the necessary data and key performance indicators to effectively control their areas. My thesis has the goal to change this. In your expert opinion: what would be possible solutions in order to align the non-medical support service applications better and to provide FM in HC Managers with regular KPIs?**

[This will further down be referred to as "your suggested solution"]

General question about <u>Technology</u>: Which technical or technological aspects have to be taken into consideration in order to implement your suggested solution?

Is there any technical/technological internal or external pressure concerning this solution?

What would be the technical/technological advantages/chances for this solution?

What would be the technical/technological disadvantages/risks for this solution

Specific question about Technology: Schwinn (2005) developed a procedure model for application integration in general. Here you can see the different steps with their outputs of his developed model:

<u>I Design of integration on application level</u>

I.1.1 **Action: Business process + parameters**
Output: Business process and KPI parameter list

I.1.2 **Action: Analyze application support**
Output: Application domain directory process/application domain matrix

I.1.3 **Action: Identify applications**
Output: Application directory *(name, domain, responsibility, financing, classification [confidential…], …)*

I.1.4 **Action: Describe applications and information flows**
Output: Application description and information flows between applications

I.2.1 **Action: Investigate requirements and characteristic of application relationships**

Output: Application relationship directory

I.2.2 **Action: Assign application relationship patterns**
Output: Application relationship pattern *(„Morphology")*

I.2.3 **Action: Observe applications context**
Output: Application context diagram

<u>**II Design of integration of the software components and data structure level**</u>

II.1.1 **Action: Assess technical requirements**
Output: Technical requirements and parameters

II 1.2 **Action: Assign implementation patterns**
Output: Implementation patterns

II.2.1 **Action: Identify implementation components**
Output: Directory of implementation components *(What has to be added so that it's applicable?)*

II.2.2. **Action: Specify solution**
Output: Implementing diagram

[Schwinn, A. (2005). Entwicklung einer Methode zur Gestaltung von Integrationsarchitekturen für Informationssysteme. Dissertation Nr. 3144. Universität St. Gallen.]

Would this procedure, according to your opinion, also be applicable in your hospital? If not: Why not? If yes: would it have to be specifically amended? How?

Specific question about Stakeholders as a <u>Social</u> aspect
According to your knowledge, who has to be involved in order to be able to apply your suggested solution?

IT staff?
Software providers?
FM staff?
Administration / Legal Department?
Board?
Other internal committees?
Medical staff?
Care staff?
R&D staff?
Patients and their dependants?
Clinics?
Other hospitals?
Insurers?
Politicians or official health departments?
Any others?

General question about Social aspects: Are there further social aspects apart from stakeholders to be considered in terms of you suggested solution?

If yes: is there internal or external pressure about this social aspect in reference to your suggested solution?

What are the advantages/chances about this social aspect in reference to your suggested solution?

What are the disadvantages/risks about this social aspect in reference to your suggested solution?

Specific question about an <u>Economic</u> aspect: Cost pressure
Does cost pressure have to be taken into consideration in order to implement your suggested solution?

Is there any internal or external pressure concerning cost pressure in context with your suggested solution?

What would be advantages/chances concerning cost pressure for your suggested solution?

What would be the disadvantages/risks about cost pressure for your suggested solution

General question about Economy
Is there other economic aspects that have to be taken into consideration in order to implement your suggested solution?

Is there any economic internal or external pressure concerning your suggested solution?

What would be the economic advantages/chances for your suggested solution?

What would be the economic disadvantages/risks for your suggested solution

General question about Political aspects:
Is there political aspects that have to be taken into consideration in order to implement your suggested solution?

Is there political internal or external pressure concerning your suggested solution?

What would be the political advantages/chances for your suggested solution?

What would be the political disadvantages/risks for your suggested solution

Specific question on Legal aspects: Data protection / Data governance:
Is there data protection/data governance aspects that have to be taken into consideration in order to implement your suggested solution?

Is there data protection/data governance internal or external pressure concerning your suggested solution?

What would be the data protection/data governance advantages/chances for your suggested solution?

What would be the data protection/data governance disadvantages/risks for your suggested solution

General question on Legal aspects
Is there other legal aspects that have to be taken into consideration in order to implement your suggested solution?

Is there other legal internal or external pressure concerning your suggested solution?

What would be the legal advantages/chances for your suggested solution?

What would be the legal disadvantages/risks for your suggested solution

General question on Ecological aspects
Is there other ecological aspects that have to be taken into consideration in order to implement your suggested solution?

Is there other ecological internal or external pressure concerning your suggested solution?

What would be the ecological advantages/chances for your suggested solution?

What would be the ecological disadvantages/risks for your suggested solution

Others
Is there any other aspect that has to be taken into consideration about your suggested solution?

Thank you very much for your time and your expertise!

Appendix 5 – Integrated Procedure Model of the Method for the Project-Specific Design of the Application and Software Component and Data Structure Layer by Schwinn (2005, p. 152)

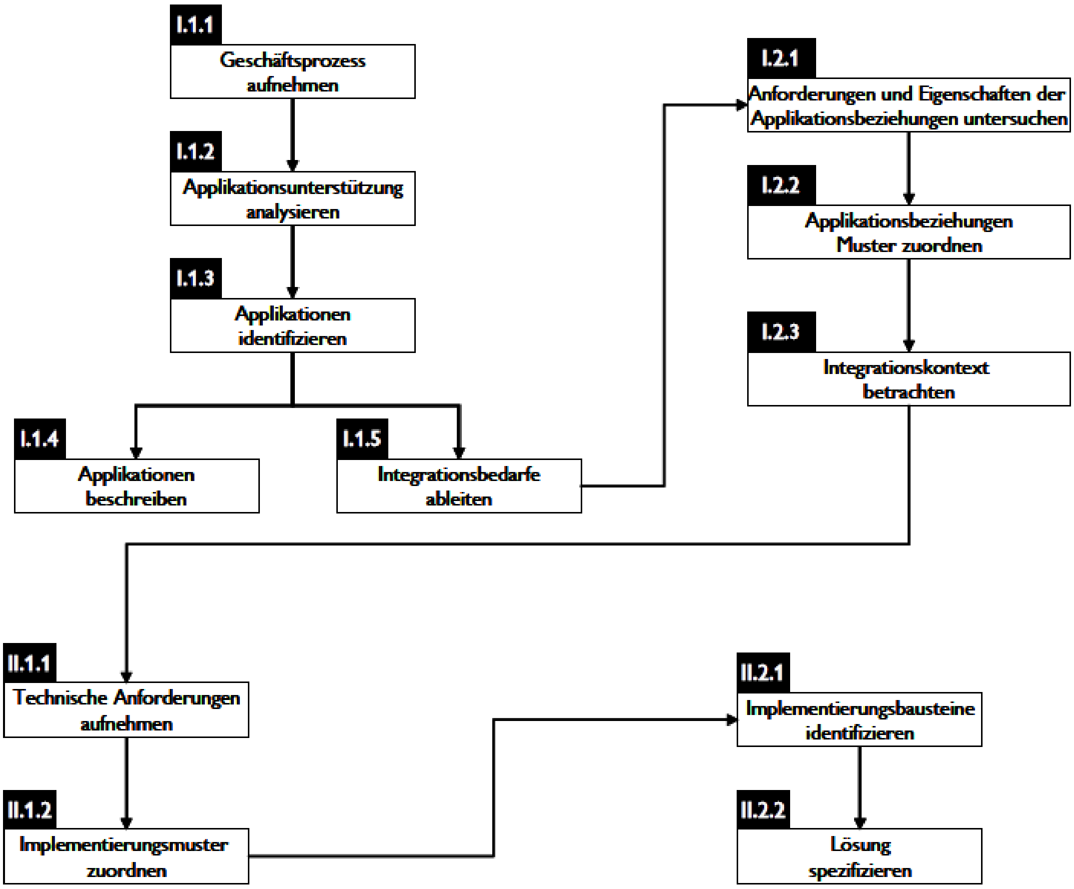


Abbildung 50: Integriertes Vorgehensmodell der Methode zur projektspezifischen Gestaltung der Applikations- und Softwarekomponenten- und Datenstrukturebene

(Source: Schwinn, A. (2005). Entwicklung einer Methode zur Gestaltung von Integrationsarchitekturen für Informationssysteme. Dissertation Nr. 3144. Universität St. Gallen. p. 152)

Appendix 6 – Extract of Example of Anonymized Interview Transcript of Interview in the Second Iteration of the "Theorising" Phase

Please note: As the interviews were conducted with German-speaking experts, the interviews were held and recorded in German; for documentation reasons within this thesis, the transcripts were translated into English (for the discussion of translation issues cf. section 3.4).

[...]

NG: As previous projects have shown, the applications of non-medical support services are currently often not well aligned on the software architecture and therefore, Managers of FM in Healthcare (comprising Logistics, Infrastructure, Safety & Security and Hospitality, see *1 page printed out separately***) often don't receive the necessary data and key performance indicators to effectively control their areas. My thesis has the goal to change this. In your expert opinion: what would be possible solutions in order to align the non-medical support service applications better and to provide FM in HC Managers with regular KPIs?**

The goal should be to integrate or couple as much as possible (2 - 5 systems should be removed)
Reportings exist in several areas
SAP-BW is the central reporting, in the background, everything is put together.
The goal would be to have end-to-end processes in SAP as reports also for FM in HC, overarching (up and downstream!) and independently of architecture based on patient process. The process will become more clear because of more transparency.
For the integration, we have to think about the cost/benefit relationship, also for interim solutions, otherwise applications should be integrated directly. We have to draw a roadmap, prioritize: mandatory stuff has to be done first, the rest has to follow.
We will introduce SAP RE-FX and will actively strive to reduce the FM application landscape. This means that the necessary applications will be enlarged and enforced, not necessary applications will be reduced or integrated in existing software.

NG: General question about <u>Technology</u>: Which technical or technological aspects have to be taken into consideration in addition to the already mentioned ones in order to implement your suggested SAP integrated solution?

The interlinking of the systems and their data has to be done and will then have to be made accessible to the management.

NG: Is there any technical/technological internal or external pressure concerning this solution?

Mobile topics will have to be tackled

NG: What would be the technical/technological advantages/chances for this SAP integrated solution?

Increase of efficiency and quality, reduction of cost, professional operations, rational decision making concerning services, work becomes more interesting and more exciting (e. g. mobile solutions), less bureaucracy

NG: What would be the technical/technological disadvantages/risks for this SAP integrated solution

Organisational changes are triggered and roles might get superfluous. We have to deal with fears: technical and existential fears. Some professions will be externalized. In addition, more data means more transparency which some people don't really want.
There is a great interdependency amongst each other and therefore things take longer.

NG: Specific question about Technology: Schwinn (2005) developed a procedure model for application integration in general:

[1 page printed out separately]

NG: Would this procedure, according to your opinion, also be applicable in your hospital? If not: Why not? If yes: would it have to be specifically amended? How?

For I.1.2 Action: Analyze application support / Output: Application domain directory process/application domain matrix: Application must be applicable otherwise the best tool is no use.
Analysis should have enough time for strategy - architecture - landscape alignment
For II.1.1 Action: Assess technical requirements / Output: Technical requirements and parameters: It's good that the technical requirements come late.

For the model in general: Documentation should be shown from the beginning and beyond step II.2.2
It is important to document even afterwards and to have a central storage/documentation

NG: Any other remarks about Technology?
Technically, a lot is possible but the people are not ready yet, are not very affine with technology. This means we have to develop together with the people in small steps. We have to pick them up and show them what will be better in the future but also increase the awareness that the complexity grows even though the surface appears to be simple. In the beginning, we should take small steps so that the people concerned can learn how to use the new technology. We have to create acceptance and to have to steadily implement new things and include all the stakeholders.

NG: Specific question about Stakeholders as a <u>Social</u> aspect
According to your knowledge, who has to be involved in order to be able to apply your suggested SAP integrated solution?

NG: Let's start with IT:
CIO: Has to approve strategic options on the highest level and decide together with the board
Application/Module Managers: Have to be involved depending on the content
Architecture Manager: Have to be involved depending on the content
Team leaders, Project managers / Department heads: Have to be involved depending on the content
IT Key Users/Super users: Have to be involved depending on the content
External IT consultants: Have to be involved depending on the content
KIS software providers and provider support: We have to distinguish between software provider and implementation provider. We have to check with them, in what extent applications (also small ones and not only SAP) can be integrated.
Mostly, they come for product presentations, then we validate and maybe go for a reference visit.
Depending on the content, we have an invitation process to follow (restrictions!) or even a WTO/GATT tender.

NG: What about FM staff?
FM Process managers: For every process, the process manager has to be picked up and we have to invest a lot of time for the transfer. We have to develop the solution as a team
FM subject areas: We have to educate the users and make marketing for the new solution when implementing
Subject Quality Manager: Has to be involved for the process guidelines and requirements
Process Manager (high level): Has to be involved for accompanying the change management process
Project leaders of subject or sub-project: Have to be involved depending on the content

NG: And the Administration or Legal department?
They have to be contacted only for process of tender, for checking legal aspects of cloud solutions, for surveillance aspects and for patient data aspects.

NG: What about the Board?
Normally specifically the Head of operations department or the Heads of divisions

NG: Do you have any other internal committees?
No, not in this context

NG: What about medical staff?
Depending on the content accompanying them when there are interfaces with patients -> this is done in a team approach

NG: And care staff?
Depending on the content accompanying them when there are interfaces with patients -> this is done in a team approach

NG: Do you have R&D involved?
Not in this context

NG: And what about patients and their dependents?
Neither

NG: Do you have other clinics to consider?
The individuals are "Stakeholders - medical staff". The clinics have to be involved upon the roll-out and on a process level. They have to be accompanied.
Sometimes they have to decide, make the process definition, have to consolidate material. It is very important to involve them early!
[…]

Appendix 7 – Applied Codes in Qualitative Data Analysis in the Second Iteration of the “Theorising” Phase

Please note: Based on the translated interview transcripts and again for documentation reasons, the analysis and the coding were conducted in English (for the discussion of translation issues cf. section 3.4).

Dokumente	555
Transcript 1	**85**
Transcript 2	33
Transcript 3	43
Transcript 4	29
Transcript 5	71
Transcript 6	45
Transcript 7	27
Transcript 8	49
Transcript 9	51
Transcript 10	48
Transcript 11	34
Transcript 12	40

Liste der Codes

Codesystem	555
External	0
Pressure/Triggers for IT alignment	0
Pressure/Triggers Technology	1
Pressure/Triggers Shareholder expectations	2
Pressure/Triggers Health Politics	16
Pressure/Triggers Law	9
Risk/Challenges of IT alignment	0
Risks/Challenges Law	13
Risk/Challenges Politics	13
Internal	0
Pressure/Triggers for IT alignment	0
Pressure/Triggers Finances	11
Pressure/Triggers Operations	17
Pressure/Triggers Hospital culture	3
Pressure/Triggers HC IT	3
Pressure/Triggers Construction of hospitals	2
Pressure/Triggers Organisation	2
Measures for IT alignment	0
Measures Stakeholdermanagement	202
Measures HC IT	88
Measures Opertations	7
Measures Business policies	5
Risks/Challenges IT alignment	0
Risk/Challenges Hospital IT	37
Risk/Challenges Stakeholders	24
Risk/Challenges Business practices	15
Risk/Challlenges Organisation	8
Risk/Challenges Hospital culture(s)	5
Risk/Challenges Hospital overall	2
Benefits of IT alignment	0
Benefit Hospital Business	42
Benefit HC IT	13
Benefit Ecology	7
Benefit more transparency	5
Benefit Stakeholders	2
Benefit increased security	1

Liste der Codes	#
Codesystem	563
External	0
Measures for IT alignment	0
Little proactive involvement of politics	2
Triggers/General conditions for IT alignment	0
Triggers/General conditions Technology	0
IoT = more IT	1
Triggers/General conditions Shareholders	2
Triggers/General conditions Health Politics	0
New regulations create pressure	1
Profitability requested	2
More transparency requested	3
Ask for static KPIs	1
Pressure for bundling services/networking	1
Political and not rational decisions	1
Very slow regulations	2
Costs a lot of tax money	1
Cost saving intentions without knowing how	1
Big impact	2
Being on governmental hospital list	1
Triggers/General conditions Law	0
Different application of health law	1
Many regulations for medical technical devices	1
Legal tenders to follow	1
Legal requirements have to be respected	9
Risk/Challenges of IT alignment	0
Risks/Challenges Law	0
Legal changes need quick implementation	1
Big pressure for/restrictions because of data protection	1
Legal changes influence IT implementations	1
Slow down of IT projects	2
Many legal requirements to be coordinated	4
Less freedom	1
Risk/Challenges Politics	0
Too much transparency might increase regulations	1
Unfit regulations about tendering	1
Financial regulations/no market prices	2
More complex tariffs	1
Insecure political decisions	4
Risk measure clear positioning	1
Federalism	0
Makes it difficult	2
Slow down of projects	1
Risk Measure Standardization	1
Political rope pulling	0
Internal	0

Triggers/general conditions for IT alignment	0
Triggers/General conditions HC IT	0
Much room for improvement	1
Architectural view/end-user driven strategy	1
Not all aspects in tools are used (yet)	1
Track & Trace	1
Software providers	0
Providers offer less features/speed than in other industries	2
Long-term relationships	1
KIS providers slow and unflexible	1
Secure full availability	1
Measure Emergency scenarios	1
Complexity within hospital context	3
Variety of topics	1
Different profiles	1
Triggers/General conditions Competitive Advantage	1
Triggers/General conditions Finances	0
Reduction of overhead	0
Increasing cost awareness	1
Need for process efficiency	2
No idea on how to reduce cost through automatization	1
Cost pressure	6
Financial restrictions/regulations	1
Triggers/General conditions Management	0
Different KPI definitions = no benchmarking possible	2
Missing definition of necessary numbers	1
Missing figures/more controlling	3
Missing basis for reflection/discussion	0
Missing decision basis	2
Triggers/General conditions Hospital culture	1
Growing stability	1
Increasing process thinking	1
Not enough ressource management	1
Subsidiary enterprises for staff retention	1
IT behind industry standards	2
Many different cultures	1
Low IT budgets	3
Backlog in IT investment	1
Missing lifecycle cost considerations	1
Doctors require individual solutions	1
Little IT security awareness/culture (Med/Care)	1
Unclear roles	1
Missing cooperation culture	2
Triggers/General conditions Operations	0
More time for the patients	1
Paperless	1
Process improvement for more patient satisfaction	1

More reports would be requested	1
Mobile applications/solutions requested	4
Triggers/General conditions Construction of hospitals	2
Triggers/General conditions Organisation	0
New professionals with good knowledge help to break traditions	1
Faster organisational change	1
Triggers/General conditions Ecology	0
Food waste	1
Simplifying and automatization would be the best eco impcat	1
Energy saving	3
In the building phase	1
Resource Management	0
Big potential	1
Partially considered	1
Ecology no/marginal argument	7
Measures for IT alignment	0
Measures Business policies	0
Internal data should stay internal	1
Clarify requirements	1
Business-oriented not political prices	1
Measures Stakeholders	0
Stakeholdermap defining roles and services	1
Donors	1
Information = Marketing = Fundraising	1
Resistant stakeholders	0
Think openly	1
Time investment	2
Early invovlement	2
Process Manager (high level)	0
Accompanying change management	1
Management	1
Allocators	1
Hospital Directors	2
Safety/Security delegates / data protection officer	4
Hospital staff overall	0
Accept/see new roles as a benefit	0
Understand processes	2
IT	0
IT Management	0
for better understanding/decisions	1
Interaction team	1
Technical IT	0
Infrastructure alignment	1
Middleware Managers	0
Alignment	1
SAP/BI Competence Center	0
Allocation of necessary figures in SAP modules	1

Driving forces	0
Identify and use as Change Agents	1
(End)Users	3
Architecture Managers	2
(BI) strategy and conception overall	1
Involvement dependent on content	1
Consultants	1
Involvement dependent on context	2
Team leaders/project managers/department heads	3
Promoters / Idea pushers	1
Involvement dependent on content	1
Application/Module Managers	4
for BI cubes and MIS	1
Involvement dependent on content	2
IT security	2
Involvement depending on context	0
IT commitees (depending on subject)	2
IT staff overall	2
General setup and interlinks have to be understood	1
(Project) Team Meetings	1
KIS provider (support)	0
Providers (support) / Implementation partners	6
For development	1
Agreements for penalties	1
Less contact with replaced providers	1
Close contact	2
Contact for integration possibilities	1
Involvement dependant on context	4
Key/Super users	0
Involvement depending on content	1
Contact with users	1
Support	0
To understand the complexity	1
Increasing importance for mobile device handling	1
Guarantee success of roll-out	1
Enough resources reserved	1
High involvement	1
Documentation	2
Education	2
Optimal service	2
Central IT/Network/Client teams	1
Involvement dependent on project	1
Guarantee success of roll-out	1
High involvement	1
Enough resources reserved	1
Contact with site support	1
CIO	4

Approval on top-level	1
Motivation/enthusiasm	1
Official support of project	1
Role concepts	1
Financial needs	2
Alignment of project fit	1
Shareholdercontact	1
FM staff	0
Report receivers	1
Small groups depending on context	1
The closer to the patient the more requirements	1
Involvement depending on context	6
Project leaders	0
Involvement depending on content	1
Subject Quality Manager	0
Process guidelines and requirements	1
Subject area	0
Marketing for new solution	1
Education of the users	1
Process Managers/Owners	1
Solution development in teamwork	1
Interdisciplinary commitees	3
IT commitee	1
Strategic commitee	0
have to be highly remunerated	1
Informal steering commitee	1
Internal customers with IT	0
Overarching topics	1
Requirements/applications	1
Weekly meetings	1
Legal Department	0
External specialist upon request	1
Involvement depending on context	1
Patient data aspects	1
Cloud solution checks	1
Compliance with governmental requirements/tenders	2
Suitability for revision	1
Provider contracts / overarching contracts	5
Board	6
CFO crucial	1
Board reporting	2
KPIs/variable and need have to be clear	4
Head of Divisions	1
Head of Operations	3
Involvement depending on context	2
specifically for expensive projects	1
Medical staff	0

Later involvement	1
MedUseBoard	1
For medical interfaces (HIS, Logistics)	2
No direct contact	1
Little contact	1
Contact difficult/roles not clear	1
Simplified official communication paths	1
Special Change Management Measures necessary	1
Involvement depending on context	2
R&D	0
Involvement depending on context	1
Care staff	0
Interlinks with patient applications	1
No direct contact	1
Important for interfaces between patient and technology	1
Specific Change Management Measures necessary	1
Involvement depending on context	4
Patients/Dependants	0
Clinics	1
Early involvement	1
Involvement/accompanying from roll-out	1
Involvement depending on context	4
Other hospitals	0
Situational cooperations	2
Insurances	0
Official requirements	1
Politicians/Official health departments	1
Satisfaction measuring institute	1
Shareholders	0
Reputation	1
Financial optimization	2
Measures Change Management	0
Step by step development toghether with people	1
Small steps to learn new technology	2
Measures Communication	1
Involve all stakeholders	1
Create acceptance	1
Awareness of growing complexity	1
Show the future benefit	1
Common communication culture	1
Common Vocabulary	1
Measures Opertations	0
Reduction of variety	2
Standardized/centralized offer	2
Outsourcing	1
expert knowledge vs. connecting solutions	1
Partially a topic/unclear	1

Measures HC IT	1
Interdisciplinary automatized data capturing	1
More granularity	1
KPI parameter definition/common nomenclatura	2
No shadow IT	1
Create appreciation for IT	1
Decision on application landscape	1
cost-benefit view	1
Suggested Reporting Solutions	0
Common platform for integration	0
common definitions and master data necessary	1
Data Warehouse	2
end-to-end process reports (both ways) based on patient process	1
Adaptation of reportings and cockpit	3
Individual reports (possibly mixed)	3
Necessary KPIs individually by operational level	1
MIS: Cockpit with reports	4
SAP on toplevel	3
Dashboard adaptable	1
BI /BI cube	8
Interlinks on a strategic level need to be clear	1
Creation of a BI standard	1
Applications	0
Reduce number of applications	1
Integrate in ERP	1
Necessary applications enlarged/enforced	1
Evaluation of HIS first	1
Specifically important logistics/dispo/transport	2
Interfaces	1
Creation of an interface standard	1
Direct/close coupled interfaces	2
Reduction of interfaces	2
Documentation	1
Filled in CMDB as a basis for understanding	1
Including Change Management process	1
Including Controlling	1
Including process definition	1
Simple/intuitively to use solutions	5
More social media touch for interdisciplinary understanding	2
Benchmarking with others	2
With few KPIs	1
Suggested process	0
Roadmap for priorisation	3
Interim solutions if necessary	1
1. Align domain architecture	1
Within hospital + all additional entities	1
a) what is really necessary	1

b) clustering of functionalities /assign to applications	1
c) consolidate	1
2. Define master date and main repository	1
3. Implementation of Data Warehouse	1
4. Enlarge to BI	1
Benefit has to be clear	1
Subject areas as drivers	0
Interlinks	1
Cost-benefit relationship	2
Integrate/couple as much as possible	2
Comparable master data	1
Benefits of IT alignment	0
Benefit hospital culture	0
Being all in the same boat	1
Benefit more transparency	5
Benefit increased security	1
Benefit better information flow	2
Benefit HC IT	0
IT for more time with patients	1
IT for overhead reduction	1
IT for paperless	1
consolidation/less interlinks/less providerhandling	1
More creative solutions	1
Better (reflection on) alignment	1
Pragmatic/useful solutions	2
No oversizing	1
Centralized standards	1
Harmonization	1
more manageability	1
central bundling with situational adjustments	1
Benefit Stakeholders	0
More time for patients/better treatment	1
No market prices/better social conditions for staff	1
Benefit Hospital Business	0
More automatization = improved processes	1
More holistic/strategic business thinking	2
More efficiency	2
Saving resources/money	5
Saved money available for patients	1
Better prices because of bigger contracts	1
Better service	1
Weaker clinics/hospitals can profit	2
Learn from other industries	1
Better quality	3
More professional operations	1
Rational decision making	3
Job enrichment	1

Less bureaucracy	1
Reporting is possible	1
Enforcement to cooperate in networks	1
Provide services for external institutions	2
Using existing potential	1
Benchmarking possible	3
Better understanding = better argumentation	6
Risks/Challenges IT alignment	0
Risk/Challenges Hospital overall	0
No standstill time in hospital	1
Great interdependencies take much time	1
Risk/Challlenges Organisation	0
Pressure in th same points	1
Overstraining of organisation	2
Unclear necessary effort	1
Superfluous/outsourced roles	3
Changes are triggered	1
Risk/Challenges Hospital culture(s)	0
Missing communication culture	1
Integration of many different cultures	1
Risk/Challenges Stakeholders	0
Hospital staff overall	0
No willingness for paying for IT services	1
Little IT knowhow / affinity	1
The human users in general	1
Not used to change	1
Overstraning of people	1
Resistance	1
Hidden agendas	1
People are not ready for technical possibilities	1
Fear	0
Fear of transparency	2
Existential fear	1
Technical fear	1
Board	0
Board not ready for BI	1
Management	0
Missing conviction by top management	1
Medical staff	0
Older/senior medical staff stick to their known processes	1
Acceptance of developments by medical staff	3
IT staff	0
Overtime	1
Missing experts	1
FM	0
Low education level with little IT knowhow	1
Risk/Challenges Hospital IT	0

Little risk when put together correctly	2
Missing IT ressources/experts	1
Unclear interrelations	1
BI	0
Currently not enough resources to deal with it	1
Wrong computations = wrong results = wrong measures	1
More data handling	1
Security	0
Include externals in security concept	1
Dilemma: public building vs. security	1
Interfaces	0
Missing interface standard	2
Smaller applications = more interfaces	1
Provider relations	0
Dependency on providers	2
Not all integrateable	1
Slow change implementations	1
Problems with technology provider	1
No total integration	1
Different existing partners	1
Complexity	1
Risk/Challenges Business practices	0
Overreaction leads to more pressure	2
Reportings	0
Uncomparable report situations	1
Wrong calculations	2
Unknown necessary KPIs	1
Unscrutinized reports	1
Missing internal information	1
Operations	0
More difficult handling of reduced storage	1
Risk Measure Safety stock	1
Resources	0
Never enough resources available	1
Risk Measure Priorization	1
Finances	0
Dilemma: need for investmens vs. savings	1

Appendix 8 – Material Processing in First Iteration of "Theorising" Phase

Material processing: Reporting style, Degree of aggregation, Degree of integrations

Main categories	Summarized categories	Time horizon
Reporting style	Individual independent reports (for every subject area out of different sources)	short-term
	SAP/ERP reports for subject areas in combination with Controlling/Finance reports	short-/mid-term
	(Adjustable) Management Information System (MIS) / Dashboard / Cockpit	short-/mid-/long-term
Degree of Aggregation	No aggregation / Directly from source	short-term
	Data Warehouse	short-/mid-term
	Business Intelligence	long-term
Degree of Integration	No integration	short-term
	Integration on User Interface	short-/mid-/long-term
	Full integration / replacing applications	long-term

Material processing: Suggested simplification of application alignment and integration for the healthcare context

Phase	Actions	Outputs	Important for HC	Incorporation of the phases by Schwinn (2005)
1: Analysis of integration requirements	- Analyze application support - applications and information flows - Application description and information flows between applications	- Application domain directory process/application domain matrix - Application directory	- Take enough time for strategy - architecture - landscape alignment - Integration of as many interfaces as possible	I.1.2 + I.1.3 + I.1.4
2: Determine application relationships requirements	- Investigate requirements and characteristic of application relationships - Assign application relationship patterns - Observe applications context	- Application relationship directory or Application relationship pattern or Application context diagram	- Mind the many different interfaces	I.2.1 + I.2.2 + I.2.3
3: Design of integration of the software components and data structure level	- Assess technical requirements - Assign implementation patterns - Identify implementation components	- Technical requirements and parameters - Implementation patterns - Directory of implementation components		II.1.1 + II.1.2 + II.2.1
4: Specify solution	- Specify solution	Implementing diagram		II.2.2

Material processing: Assessed pressures/triggers, suggested measures, expected risks/challenges and benefits for internal and external view

		Assessed pressures/triggers	Proposed measures	Expected risks/challenges	Expected benefits
External context	Health Politics	- Regulations create pressure but also slowness - Political request for profitability, bundling of services, more transparency and KPIs	- Central standardization with regional adaptation possibilities	- Insecure political decisions - Federalistic procedures - Financial restrictions/regulations - Increased transparency might cause more desires/pressures from political actors	- More transparency on processes
	Economical	- Shareholder expectations			
	Technological	- More IoT = more IT - Faster change/digitalisation is a fact			
	Legal	- Legal requirements	- Ensure documentation	- Unfit tendering regulations	
Internal context	Finances	- Cost pressure - Increasing cost awareness	- Check cost-benefit relationships	- Backlog in IT investments	- More efficiency, saving resources / reducing cost
	Management	- Need for more figures/controlling as basis for decision/argumentation and benchmarking - Creation of competitive advantage	- Find and implement adequate reporting and benchmarking solutions - Ensure common definitions of parameters - Check automatized data capturing - Prioritization	- Missing readiness for sophisticated/BI solutions - Missing management conviction	- More transparency -> better information flow -> better understanding -> better argumentation + better decisions = better services, better quality and more security - More holistic business thinking - Possibility of comparisons/benchmarking with others
	Operations / Business practices	- More reports requested - Mobile/paperless applications - Patient orientation - New knowledge carriers enable breaking with old traditions	- Userfriendly (mobile) solutions - Standardisation	- Resistance due to existential/technical/change fears of involved stakeholders - Fear of too much transparency by some actors Low IT affinity/maturity of users - Hidden agendas - Missing willingness of cooperation - Unclear roles - Incorrect/non-comparable/useless reports - Overstraining of organisation	- More time for patients
	Hospital culture	- Increasing resource/process thinking	- Create appreciation for IT	- Handling the hospital complexity and its different existing discipline cultures - Missing corporate culture - Time consuming interdependencies	- More a feeling to sit in the same boat
	Healthcare IT	- Growing maturity - Complexity increasingly difficult to handle	- Adequate stakeholder and change management step-by-step co-development/learning	- Dependencies on (unfit) providers - Missing resources/experts for sophisticated/BI solutions - Generated data might be incorrect - Missing interface standards - Difficulty to secure full availiability	- Reduction of applications and interfaces and pragmatic solutions enable better manageability of interlinks, applications and providers - Centralized standards allow better alignment

Material processing: Analysed stakeholder clusters

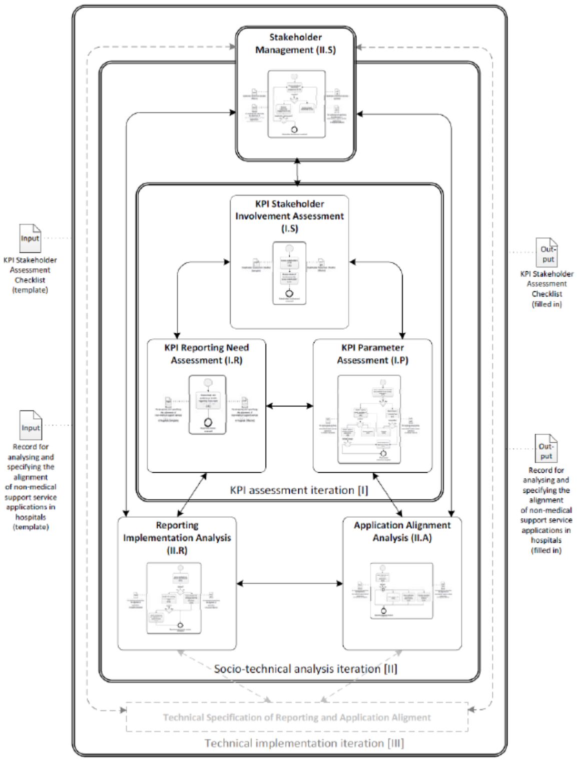
Con-text	Main category	Category	Specific stakeholders	Reason/goal for stakeholder involvement
Internal	Service Levels	Strategic Management Services	The Board/Management	to ensure the financing, to legitimize and endorse the projects, for strategic alignment
			IT Management / CIO	
			Process Managers	to ensure the overall alignment
			Safety & Security Delegates / Data Protection Officers	to ensure safety/security and data protection depending on the context
		Management Support Services: IT Services	Team Leaders / Project	for alignment, acceptance and implementation accross teams and projects
			IT commmittees	for alignment, acceptance and implementation accross IT fields
			Application / Module Managers	to analyze, understand, develop and implement the technical aspects
			Architecture Managers	
			Middleware Managers	
			SAP / BI Compentence Center	
			Network/Client team	
			IT security	to ensure the security
			IT Support	for a thorough understanding of the whole context in order to be able to
			Key/Super users	for understanding, acceptance and implementation in the operational
			IT staff oveall	for understanding and acceptance accross IT fields
		Management Support Services: Legal	Legal Department	in case of contractual needs
			Finance & Controlling	to analyze the current situation and requirements, to ensure acceptance and delivery of necessary data
			HRM	
			Administration	
			Marketing & Communication	to analyze the current situation and requirements and to ensure
		Non-medical Support Services: Logistics	Procurement	to name the exact requirements, to ensure acceptance and to implement in the operational mode
			Inventory Management	
			Transport & Distribution	
			Disposal & Recycling	
		Non-medical Support Services: Infrastructure	Maintenance	
			Space Management	
			Energy	
		Non-medical Support Services: Hygiene, Safety & Security	Safety	
			Security	
			Cleaning	
			Sterilisation	
		Non-medical Support Services: Hotel Services	Catering	
			Textiles	
			Accomodation Administration & Operation of Properties	
			Hotel Various	
		Medical Support Services	Care staff	to name the exact requirements, to ensure acceptance and to implement in the operational mode
		Medical Core Services	Medical staff	
			Clinics	
		Hospital overall	Interdisciplinary committees	to ensure alignment, acceptance and implementation accross disciplines
			Hospital staff overall	
			Resistant stakeholders	to assess and overcome reasons for resistance
			Driving forces	for lobbying and to profit from positive motivation
External	IT	Software provider(s)	HIS providers	to assess technical requirements for integration or to ensure connectivity
			ERP providers	
			CAFM providers	
			Individual software providers	
		Consultants	Implementation consultants	to acquire missing knowhow
	Ownership	Privately owned	Shareholders	depending on legal structure, need for communication and financing
		Governmentally owned	Politicians / official health departments	
		Foundation owned	Donors	

Appendix 9 – Documentation of the Procedure Reference Model Including the Metamodel, the Component Models and the Intput Documents to be Evaluated in the First Iteration of the "Evaluating" Phase

Please note: As the interviews were conducted with German-speaking experts, the documentation was also provided in German (for the discussion of translation issues cf. section 3.4).

Procedure Reference Model for the Alignment of Non-medical Support Services Applications in Hospitals

- for the correct configuration and display of relevant key performance indicators



1. **Brief guide (p. 2)**
2. **Documentation and background information (p. 3 – 23)**

Procedure Reference Model for the Alignment of Non-medical Support Services Applications in Hospitals

- for the correct configuration and display of relevant key performance indicators

1. Brief guide

For whom?

All those who manage and/or align applications in the context of non-medical support services in hospitals

Why?

To ensure that all desired or necessary KPIs of non-medical support services can be provided in the desired form of reporting and aligned following a structured procedure

How?

- Choose the non-medical support area where reporting or an alignment is to be undertaken
- Open the file KPI_Stakeholder_Assessment_Checklist.xlsx; go through all individual KPIs and fill in the table according to your needs (note the cell comments); if actions are necessary: schedule and execute
- Open the file Record_for_analysis+specification_(template).xlsx; go through all individual KPIs and fill in the table according to your needs (note the cell comments); if actions are necessary: schedule and execute
- If more background information is needed: read the explanations on the following pages

Procedure Reference Model for the Alignment of Non-medical Support Services Applications in Hospitals

- for the correct configuration and display of relevant key performance indicators

2. Documentation and Background Information

Table of Contents

Table of Figures

1 Introduction

1.1 Definitions

1.1.1 Definition of non-medical support services

Non-medical support services in hospitals are defined according to Gerber (2016):

Area	Subject-area
Logistics	Procurement, Inventory Management, Transport & Distribution, Disposal & Recycling
Infrastructure	Maintenance, Space Management, Energy
Hygiene, Safety & Security	Safety, Security, Cleaning, Sterilization
Hotel Services	Catering, Textiles, Accommodation Administration & Operation of Properties, Hotel Various

1.1.2 Definition of KPIs per subject-area

The necessary KPIs in the subject areas mentioned above were developed in a previous project together with industry and hospital partners. The development and documentation of the corresponding KPIs are available on https://www.zhaw.ch/en/lsfm/institutes-centres/ifm/about-us/hospitality-management/fm-in-healthcare/remos/kenkas/. A KPI always has at least two parameters. Key performance indicator and KPI are applied synonymously.

1.1.3 Definition of Stakeholder

Stakeholders are all those who are concerned or involved in any way.

1.2 Starting position

Projects which have conducted have revealed that many Swiss hospitals currently have not only implemented many different non-aligned applications in the context of non-medical support services, but also that the managers responsible in the non-medical area do not have all the necessary KPIs and reporting available. The first fact presents a high risk of errors and is inefficient and expensive, the second one means that services and resources cannot be verified and controlled systematically.

To respond to this problem, a procedure reference model for the alignment of non-medical support services applications in hospitals was developed in the context of a dissertation with the goal to ensure the correct reporting and display of relevant KPIs.

1.3 Goal and benefit of the procedure reference model

The goal of the procedure reference model is to make it possible for managers responsible for non-medical support services and application management in hospitals to ensure that all desired or necessary KPIs for non-medical support services are available in the desired reporting form and that they can be aligned with the help of a structured procedure. The procedure reference model is intended to support the clarification and the reporting of specific KPIs and/or the alignment of the applications involved in the context of non-medical support services if needed.

The intention of the model is that on the one hand it is systematic and holistic, while also being applicable in practice and thus pragmatic.

1.4 Overarching Goal

By the means of a better alignment of applications in the non-medical area of hospitals and by the generation of necessary KPIs, a cost reduction in the operational execution and the maintenance of the applications is expected as well as better control of the non-medical services and thus more cost transparency and resource optimization, not only in the sense of a sustainable business, but also in the sense of an optimised service towards the patients.

1.5 Content and Goal of this Documentation

This documentation explains the basic principles and interdependencies of the procedure reference model for the alignment of non-medical support services applications in hospitals.

The goal of this documentation is that people who want to use the model can easily comprehend the interrelations and basic ideas, and quickly and simply find answers to possible questions.

1.6 Target group of the document

This document is intended for the use for all people who manage and/or align applications in the context of non-medical support services in hospitals.

1.7 Delimitation

The model – and thus also the documentation – addresses the analysis, but not with the technical implementation of the application alignment.

Medical applications will not be addressed either.

1.8 Contact / Feedback

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2 Documentation of the procedure reference model for the alignment of applications non-medical support services applications in hospitals

2.1 Introduction to the basic principles of the model

- The principles of the procedure reference model are defined in the metamodel.

- The procedure principle is iterative, both within and between the KPI assessment iteration and the socio-technical analysis iteration

- The two input documents are the two spreadsheet templates
  1st KPI_Stakeholder_Assessment_Checklist.xlsx
  2nd Record_for_analysis+specification_(template).xlsx

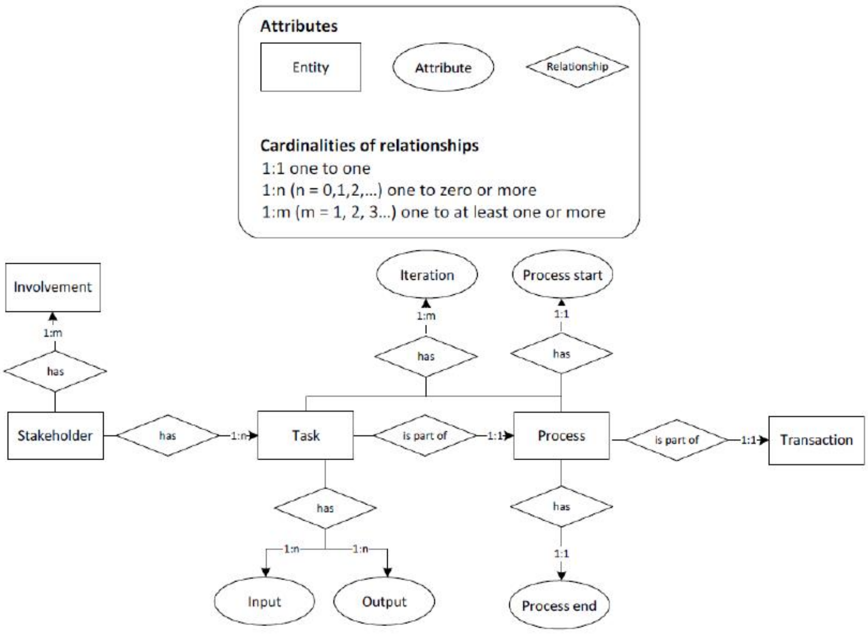
- The input documents are filled out continuously and thus become output documents

- All model parts, input documents as well as this documentation will be [after the publication of the dissertation] freely available and can be applied and adapted according to the requirements of the individual institutions; the tools chosen were therefore consciously the widely-applied Microsoft Office applications as well as standardised modelling languages.

2.2 Metamodel

The metamodel was designed using the Entity Relationship Diagram notation and is presented in Figure 1.

Modified Entity Relationship Model notation (Modified Chen-Notation) based on Academic dictionaries and encyclopedias (n.d).; Chen (1976); Chen (1981); Chen (1991); Chen (2002)



Explication:
A stakeholder has at least one involvement, can have different involvements (1:m)
A stakeholder can have no, one or many specific tasks (1:m)
A task can have no, one or many inputs (1:n)
A task can have no, one or many outputs (1:n)
A task can have one or many iterations (1:m)
A task is part of one specific process (1:1)
A process has exactly one process start (1:1)
A process has exactly one process end (1:1)
A process is part of exactly one transaction (1:1)

Figure 1: Metamodel of the procedure reference model for the alignment of non-medical support service applications in hospitals

2.3 Procedure reference model

The procedure reference model was designed using the BPMN 2.0 notation. The notation is presented in Figure 2 and the model itself in Figure 3.

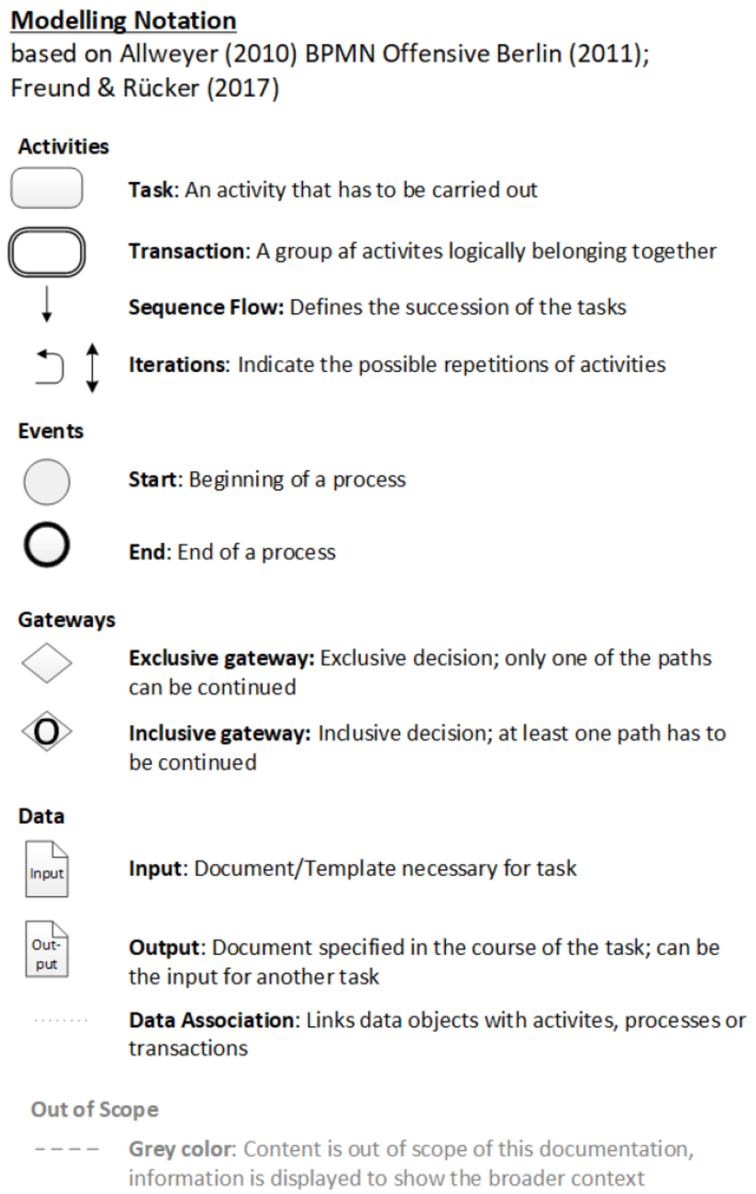


Figure 2: Notation of the procedure reference model

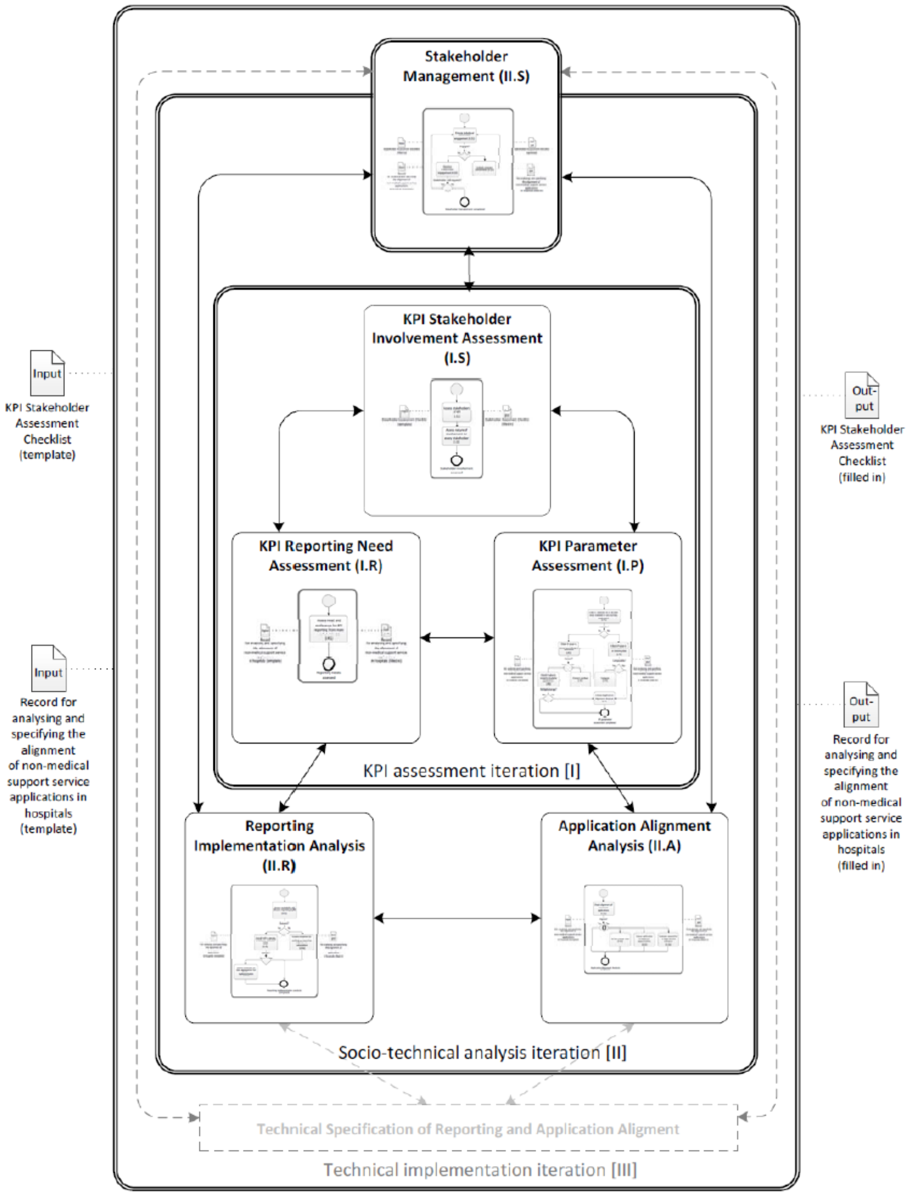


Figure 3: Procedure reference model for the alignment of non-medical support service applications in hospitals

The procedure reference model comprises two iterations: the KPI Assessment Iteration and the Socio-technical Analysis Iteration. Every iteration consists of three process models:
KPI Assessment Iteration:

- Stakeholder Involvement Assessment
- Parameter Assessment
- Reporting Need Assessment

Socio-technical Analysis Iteration

- Reporting Implementation Analysis
- Application Integration Analysis
- Stakeholder Management

A previously conducted survey has shown that the technical implementation is not the main issue, but much more the stakeholder management; this aspect was therefore positioned as the visual centre of the model.

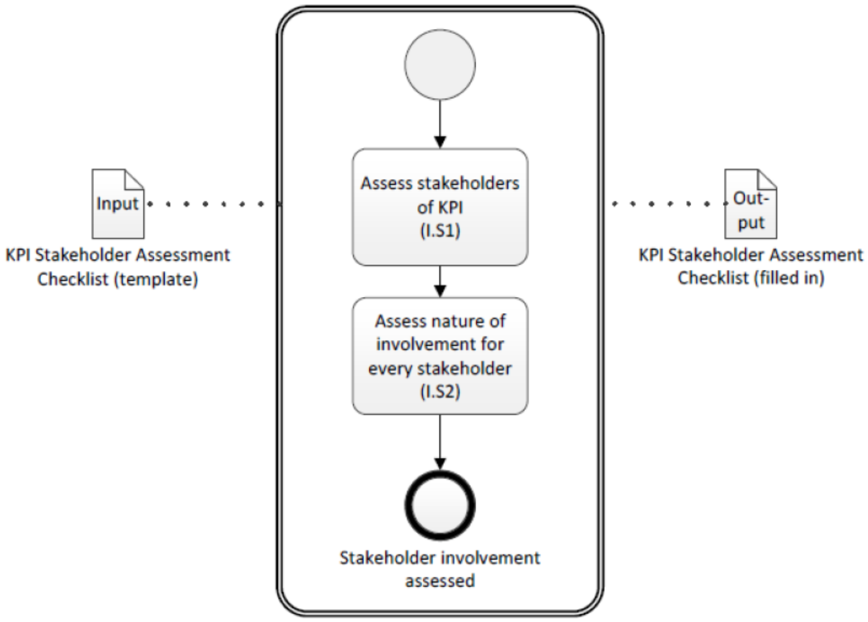
2.4 Process models

The process models are, like the procedure reference model, designed in the BPMN 2.0 notation as illustrated in Figure 2.

2.4.1 Process model of the KPI Assessment Iteration [I]

The processes are iterative (c.f. chapter 2.1) and can therefore be dealt with in various orders according to the specific needs – therefore, the order presented below is not mandatory.

2.4.1.1 KPI-Stakeholder Involvement Assessment Process [S]

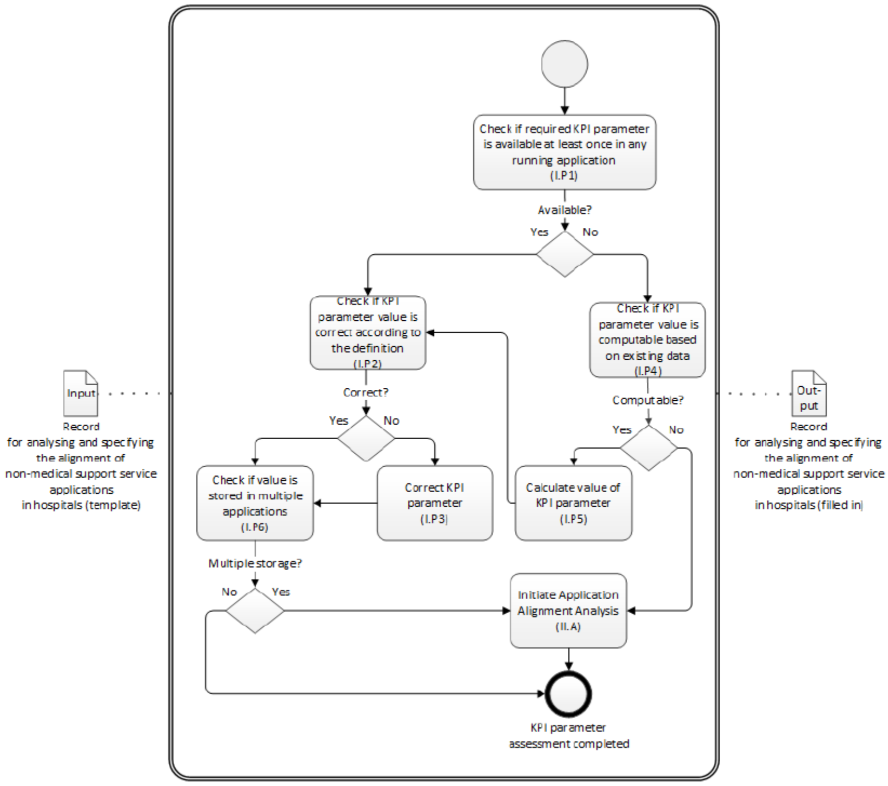


ID	Activity	Explanation
I.S1	Assess Stakeholder of KPIs	The input document serves as a checklist for identifying the stakeholders of the desired/required KPI. The goal is that all the essential stakeholders from the different areas are known to facilitate stakeholder management The input document has to be filled in accordingly.
I.S2	Assess nature of involvement for every stakeholder	In order to derive the stakeholder management measures, it is important to clarify in what form and to what extent a stakeholder is involved in the further process. The input document has to be filled in accordingly.

Input document: KPI_Stakeholder_Assessment_Checklist.xlsx (URL see chapter 4.2)

2.4.1.2 KPI Parameter Assessment Process [P]

As a KPI consists of at least two parameters (compare chapter 1.1.2), for every KPI the corresponding parameters have to be assessed separately, which means at least two iterations for every KPI.

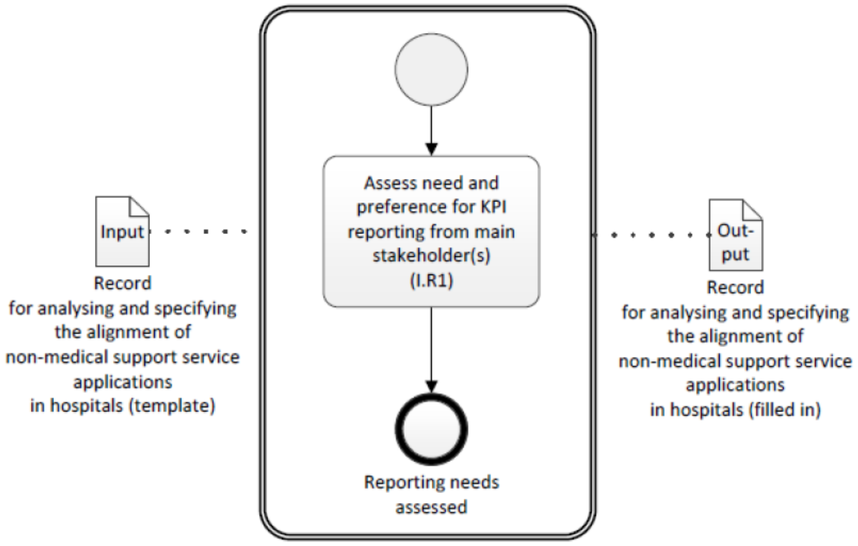


ID	Activity	Explanation
I.P1	Check if required KPI parameter is available at least once in any running application	Is the desired/necessary KPI and its parameters available at least once in any application? The input document has to be filled in accordingly.
I.P2	Check if KPI parameter value is correct according to the definition	Is the desired/necessary KPI and its parameters correct according to the KPI definition (either defined in-house or under https://www.zhaw.ch/en/lsfm/institutes-centres/ifm/about-us/hospitality-management/fm-in-healthcare/remos/kenkas/.) The input document has to be filled in accordingly.
I.P3	Correct KPI parameter	If the value is not correct according to the definition, it has to be corrected with the appropriate measures. The input document has to be filled in accordingly.

I.P4	Check if KPI parameter value is computable based on existing data	If the desired/necessary KPI parameter value is not yet available, check if the value can be calculated according to the definition on the basis of the, available partial values. The input document has to be filled in accordingly.
I.P5	Calculate value of KPI parameter	If the desired/necessary KPI parameter values can be calculated on the basis of available partial values, the calculation has to be executed. The input document has to be filled in accordingly.
I.P6	Check if value is stored in multiple applications	In order to avoid redundancies, check if the KPI parameter is stored in multiple applications. The input document has to be filled in accordingly.
IIA	Initiate Application Alignment Analysis (II.A)	See chapter 2.4.2.2

Input document: Record_for_analysis+specification_(template).xlsx (URL see chapter 4.2)

2.4.1.3 KPI Reporting Need Assessment-Process [R]

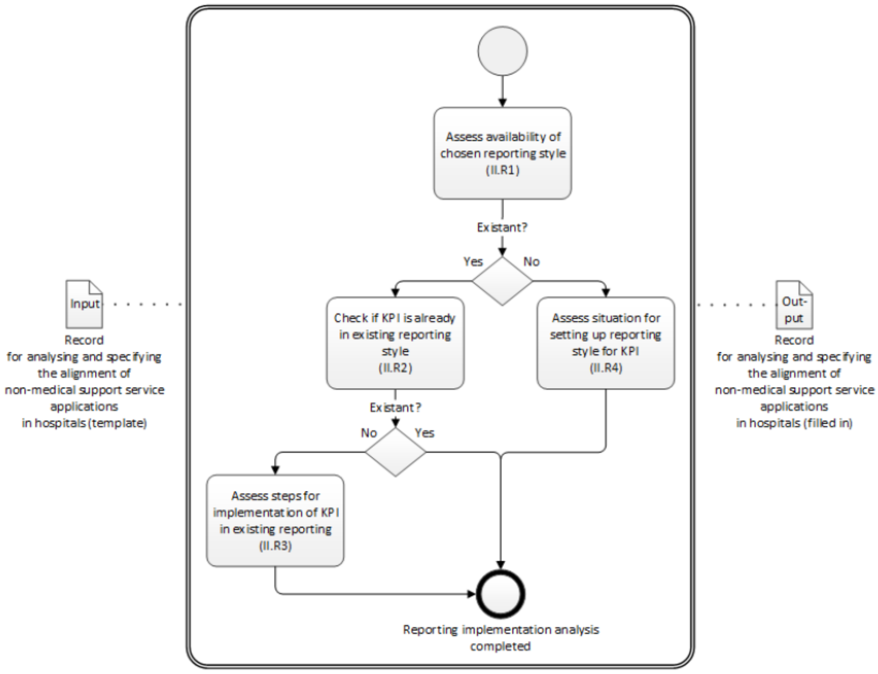


ID	Activity	Explanation
I.R1	Assess need and preference for KPI reporting from main stakeholder(s)	The input document supports the assessment of the KPI need and the reporting preferences. The goal is to handle the KPI reporting as optimally as possible with respect to the cost-benefit relationship. The input document has to be filled in accordingly.

Input document: Record_for_analysis+specification_(template).xlsx (URL see Chapter 4.2)

2.4.2 Socio-technical Analysis Iteration [II]

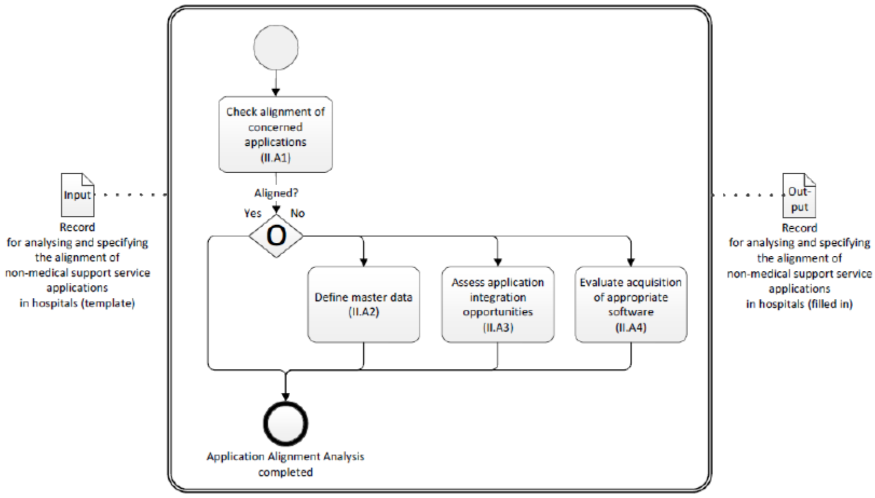
2.4.2.1 Reporting Implementation Analysis Process [R]



ID	Activity	Explanation
II.R1	Assess availability of chosen reporting style	It must be clarified whether the reporting style the main stakeholder desires is already being applied. The input document has to be filled in accordingly.
II.R2	Check whether the KPI is already in the existing reporting style	If the reporting style is available, clarify whether the KPI concerned is already or could be displayed. The input document has to be filled in accordingly.
II.R3	Assess steps for implementation of KPI in existing reporting	If the KPI concerned is not yet displayed in the desired reporting style, check whether the KPI can be inserted. The input document has to be filled in accordingly.
II.R4	Assess situation for setting up reporting style for KPI	If the reporting style is not available, ascertain whether the desired reporting style can be set up and implemented. The input document has to be filled in accordingly.

Input document: Record_for_analysis+specification_(template).xlsx (URL see Chapter 4.2)

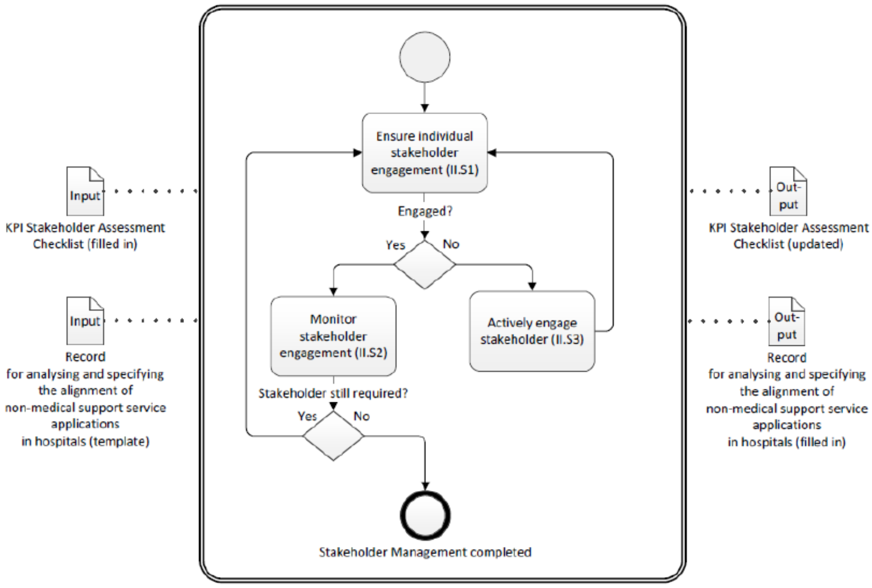
2.4.2.2 Application Alignment Analysis Process [A]



ID	Activity	Explanation
II.A1	Check alignment of applications concerned	The goal is to reach a compatible, redundancy free application alignment, which necessitates a clarification of whether the applications involved in the KPI reporting are aligned. The input document has to be filled in accordingly.
II.A2	Define master data	If the applications involved in the KPI reporting are not aligned, it has to be clarified which of the existing systems is the master. The input document has to be filled in accordingly.
II.A3	Assess application integration possibilities	If the applications involved in the KPI reporting are not aligned, the possibilities for an application integration should be assessed. The input document has to be filled in accordingly.
II.A4	Evaluate acquisition of appropriate software	If the applications involved in the KPI reporting are not aligned, the acquisition of a suitable software can be evaluated. The input document has to be filled in accordingly.

Input document: Record_for_analysis+specification_(template).xlsx (URL see Chapter 4.2)

2.4.2.3 Stakeholder Management Process [S]



ID	Activity	Explanation
II.S1	Ensure individual stakeholder engagement	Alongside the content and technology-related aspects, it is essential to be aware of the importance of stakeholder management. It is important that the engagement of stakeholders is continuously ensured. The input document has to be filled in accordingly.
II.S2	Monitor stakeholder engagement	The maintenance of stakeholder engagement has to be consciously monitored regularly. The input document has to be filled in accordingly.
II.S3)	Actively engage stakeholder	If the engagement of stakeholders is not ensured, the engagement has to be actively induced. The input document has to be filled in accordingly.

Input documents : KPI_Stakeholder_Assessment_Checklist.xlsx and Record_for_analysis+specification_(template).xlsx (URLs see chapter 4.2)

2.5 Input documents

2.5.1 Input document: KPI Stakeholder Assessment Checklist

The input document "KPI Stakeholder assessment checklist" is a Microsoft Excel document.

The goal of the input documents is to support the process.

The document consists of four areas displayed in different colours as illustrated in Figure 4:

- Grey: Space for KPIs/parameters
- Darker blue: Within the different subject areas, typical stakeholders are listed. The list can be modified according to individual needs by inserting or deleting rows. The specific names have to be recorded within the different subject-areas for every KPI.
- Light blue: Nature of stakeholder involvement; in the top left legend, there are different suggestions which can be selected from the drop-down list within the correspondingly coloured section. If needed, further/other differentiations can be used.
- Yellow: Stakeholder management measures; in the top right legend, there are different suggestions which can be selected from the drop-down list within the correspondingly coloured section. If needed, further/other differentiations can be used.

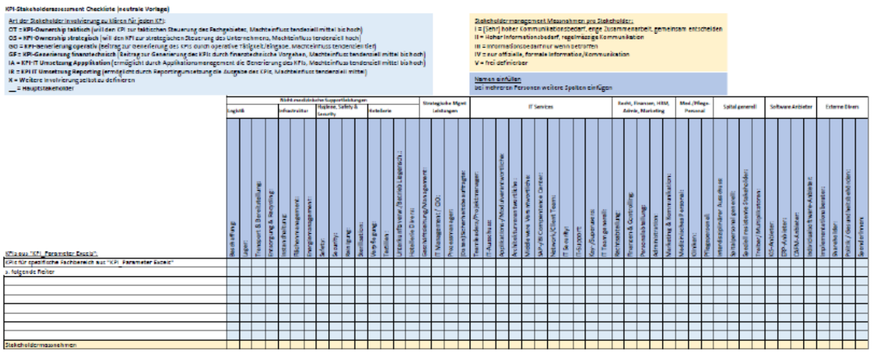


Figure 4: Input document "KPI Stakeholder assessment checklist"

In addition to a neutral template, a corresponding tab is prepared for each subject area, as shown in Figure 5.

Figure 5: Tabs in the input documents

For the access to the input document, see chapter 4.2

2.5.2 Input document: Record for analysing and specifying the alignment of non-medical support service applications in hospitals (template)

The input document “Record for analysing and specifying the alignment of non-medical support service applications in hospitals (template)” is a Microsoft Excel document.

The goal of the input document is to support the process.

As illustrated in Figure 6: Input document: , the document consists of, the section with the listed KPIs (analogous to input document “KPI Stakeholder assessment checklist”) and the detailed activities according to the process models which can easily be identified by the explicit ID.
As shown in Figure 6, the document consists of the area with the listed KPIs (analogous to the input document "KPI Stakeholder Assessment Checklist") and the individual activities according to the process models - to be clearly identified by the ID.

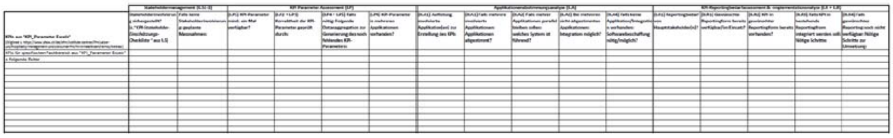


Figure 6: Input document: Record for analysing and specifying the alignment of non-medical support service applications in hospitals (template)

Where appropriate, a comment was added, identifiable by a red triangle in the cell in the upper right hand corner. By placing the cursor on the red triangle, the comment appears as shown in Figure 7.

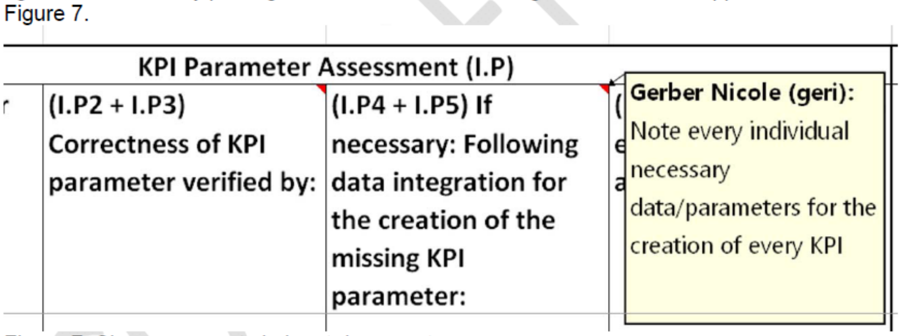


Figure 7: Show comments in input document

Yes/No answers can be chosen via dropdown lists, all other cells can be filled in with free text.

In addition to a neutral template, a corresponding tab is also prepared for each subject-area (see Figure 5).

For the access to the input document see chapter 4.2.

3 References

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4 Appendices

4.1 Digital models in Microsoft Visio

[In a final version the documents will be online and linked. Until the dissertation is published, the documents remain confidential and only available by bilateral agreements]

4.1.1 Metamodel

[URL]

4.1.2 Procedure reference model

4.1.2.1 KPI Stakeholder Involvement Assessment Process [S]

[URL]

4.1.2.2 KPI Parameter Assessment Process [P]

[URL]

4.1.2.3 KPI Reporting Need Assessment Process [R]

[URL]

4.1.2.4 Reporting Implementation Analysis Process [R]

[URL]

4.1.2.5 Application Alignment Analysis Process [A]

[URL]

4.1.2.6 Stakeholder Management Process [S]

[URL]

4.2 Digital input documents in Microsoft Excel

[In a final version the documents will be online and linked. Until the dissertation is published, the documents remain confidential and only available by bilateral agreements]

4.2.1 Input document: KPI Stakeholder Assessment Checklist

[URL]

4.2.2 Input document: Record for analysing and specifying the alignment of non-medical support service applications in hospitals (template) [URL]

[URL]

Input document KPI_Stakeholder_Assessment_Checklist, first sheet [Original presented in A3 format]

KPI Stakeholder Assessment Checklist (neutral template)

Type of stakeholder involvement to be clarified for every KPI:
OT = KPI ownership tactical (wants the KPI for tactical controlling of subject area, power influence presumably medium to high)
OS = KPI ownership strategic (wants the KPI for strategic controlling of the enterprise, power influence presumably high)
GO = KPI generator operational (contributes to generation of KPI by operational acitivites/data entering, power influence presumably low)
GF = KPI generator on financial side (contributes to generation of KPI on financial side, power influence presumably medium to high)
IA = KPI IT impl. of application (enables the generation of the KPI by management of application, power influence presumably medium to high)
IR = KPI IT impl. of reporting (enables the display of the KPI by implementing the reporting, power influence presumably medium)
X = Others Involvement to define individually
__ = Main stakeholder

Stakeholder management measures for every stakeholder:
I = (Very) high need for communication, close cooperation, joint decisions
II = High need for information, regular communication
III = Need for information only when affected
IV = only official, formal information / communication
V = to be defined individually

Fill in names
if more than one person, insert rows

	Non-medical support services																Strategic Mgmt Services				IT Services											Legal, Finance, HRM, Admin, Marketing					Medical staff			Hospital overall				Software provider(s)				External diverse			
	Logistics				Infra-structure			Hygiene, Safety & Security				Hotel Services																																						
KPIs from "KPI_Parameter Excels":	Procurement:	Inventory Management:	Transport & Distribution:	Disposal & Recycling:	Maintenance:	Space Management:	Energy:	Safety:	Security:	Cleaning:	Sterilisation:	Catering:	Textiles:	Accomm. Admin. & Op. of Properties:	Hotel Various:	The Board/Management:	IT Management / CIO:	Process Managers:	(Data)Safety&Security Officers:	Team Leaders/Project Managers:	IT committees:	Application/Module Managers:	Architecture Managers:	Middleware Managers:	SAP/BI Compentence Center:	Network/Client team:	IT security:	IT Support:	Key/Super users:	IT staff oveall:	Legal Department:	Finance & Controlling:	HRM:	Administration:	Marketing & Communication:	Medical Services:	Clinics:	Care staff:	Interdisciplinary committees:	Hospital staff overall:	Resistant stakeholders:	Driving forces:	HIS providers:	ERP providers:	CAFM providers:	Individual software providers:	Implementation consultants:	Shareholders:	Politicians / official health depart.:	Donors:
KPIs for specific subject area from "KPI_Parameter Excels"																																																		
see following tabs																																																		
Stakeholder measures																																																		

Input document KPI_Stakeholder_Assessment_Checklist, second sheet [Original presented in A3 format]

KPI Stakeholder Assessment Checklist for subject area Procurement

Type of stakeholder involvement to be clarified for every KPI:
OT = KPI ownership tactical (wants the KPI for tactical controlling of subject area, power influence presumably medium to high)
OS = KPI ownership strategic (wants the KPI for strategic controlling of the enterprise, power influence presumably high)
GO = KPI generator operational (contributes to generation of KPI by operational acitivites/data entering, power influence presumably low)
GF = KPI generator on financial side (contributes to generation of KPI on financial side, power influence presumably medium to high)
IA = KPI IT impl. of application (enables the generation of the KPI by management of application, power influence presumably medium to high)
IR = KPI IT impl. of reporting (enables the display of the KPI by implementing the reporting, power influence presumably medium)
X = Others Involvement to define individually
__ = Main stakeholder

Stakeholder management measures for every stakeholder:
I = (Very) high need for communication, close cooperation, joint decisions
II = High need for information, regular communication
III = Need for information only when affected
IV = only official, formal information / communication
V = to be defined individually

Fill in names
if more than one person, insert rows

	Non-medical support services															Strategic Mgmt Services				IT Services											Legal, Finance, HRM, Admin, Marketing					Medical staff			Hospital overall				Software provider(s)				External diverse			
	Logistics				Infra-structure			Hygiene, Safety & Security				Hotel Services																																						
KPIs from "KPI_Parameter Excels":	Procurement:	Inventory Management:	Transport & Distribution:	Disposal & Recycling:	Maintenance:	Space Management:	Energy:	Safety:	Security:	Cleaning:	Sterilisation:	Catering:	Textiles:	Accomm. Admin. & Op. of Properties:	Hotel Various:	The Board/Management:	IT Management / CIO:	Process Managers:	(Data)Safety&Security Officers:	Team Leaders/Project Managers:	IT committees:	Application/Module Managers:	Architecture Managers:	Middleware Managers:	SAP/BI Compentence Center:	Network/Client team:	IT security:	IT Support:	Key/Super users:	IT staff overall:	Legal Department:	Finance & Controlling:	HRM:	Administration:	Marketing & Communication:	Medical Services:	Clinics:	Care staff:	Interdisciplinary committees:	Hospital staff overall:	Resistant stakeholders:	Driving forces:	HIS providers:	ERP providers:	CAFM providers:	Individual software providers:	Implementation consultants:	Shareholders:	Politicians / official health depart.:	Donors:
Proportion of costs of externally rendered procurement services in %: Costs of externally rendered procurement services / Total costs of rendered procurement services * 100																																																		
Total costs in the subject area of procurement per inpatient case: Total costs in the subject area of procurement / Number of inpatient cases																																																		
Total costs in the subject area of procurement per outpatient case: Total costs in the subject area of procurement / Number of outpatient cases																																																		
Total costs in the subject area of procurement per care day: Total costs in the subject area of procurement / Number of care days																																																		
Total costs in the subject area of procurement in relation to the total costs of the hospital: Total costs in the subject area of procurement / Total costs of the hospital																																																		
Proportion of the goods value of non-medical procurement to the total goods value in the subject area of procurement: Goods value of medical procurement / Total goods value in the subject area of procurement * 100																																																		
Ratio of goods value medical procurement vs. non-medical procurement: Goods value of medical procurement / Goods value of non-medical procurement																																																		
Total costs in the subject area of procurement per number of order item: Total costs in the subject area of procurement / Total number of order items																																																		
Proportion of personnel expenditures in the subject area of procurement to goods value in the subject area of procurement: Personnel expenditures in the subject area of procurement / Goods value in the subject area of procurement																																																		
Average throughput time order processing: Number of effective throughput times of all executed orders / Total number of executed orders																																																		
Stakeholder measures																																																			

Input Document Record_for_analysis+specification_(template), first sheet [Original presented in A3 format]

Record for analysing and specifying the alignment of non-medical support service applications in hospitals (template)

For instructions to fil in see comments behind red corners or choose via drop-down list

	Stakeholder Management (II.S1-3)		KPI Parameter Assessment (I.P)				Application Alignment Analysis (II.A)					KPI Reporting Need Assessment & Implementation Analysis (I.R + II.R)				
KPIs aus "KPI_Parameter Excels" (https://www.zhaw.ch/en/lsfm/institutes-centres/ifm/about-us/hospitality-management/fm-in-healthcare/remos/kenkas/)	Stakeholder involvement assessed? (see "*KPI Stakeholder Assessment Checklist*" from I.5)	If no stakeholder engagement yet: planned action:	(I.P1) KPI parameter available at least once?	(I.P2 + I.P3) Correctness of KPI parameter verified by:	(I.P4 + I.P5) If necessary: Following data integration for the creation of the missing KPI parameter:	(I.P6) KPI parameter in existent in multiple applications?	(II.A1) List of involved application(s) for the generation of the KPI	(II.A1) If multiple involved applications: applications aligned?	(II.A2) If multiple applications shall remain existent in parallel: which one is the master data?	(II.A3) If multiple non-aligned applications: Integration possible?	(II.A4) If no application/integration available: Acquisition of software necessary/possible?	(I.R1) Reporting need of main stakeholder(s)?	(II.R1) Desired form of reporting already available/in use?	(II.R2) KPI in desired form of reportng already available?	(II.R3) If KPI shall be integrated in existent form of reporting: necessary steps:	(II.R4) If desired reporting is not available yet: necessary steps for the implementation:

Input Document Record_for_analysis+specification_(template), second sheet

[Original presented in A3 format]

Record for analysing and specifying the alignment of non-medical support service applications in hospitals (template)

For instructions to fill in see comments behind red corners or choose via drop-down list

	Stakeholder Management (II.S1-3)		KPI Parameter Assessment (I.P)				Application Alignment Analysis (II.A)					KPI Reporting Need Assessment & Implementation Analysis (I.R + II.R)				
KPIs aus "KPI_Parameter Excels" (https://www.zhaw.ch/en/lsfm/institutes-centres/ifm/about-us/hospitality-management/fm-in-healthcare/remos/kenkas/)	Stakeholder involvement assessed? (see "*KPI Stakeholder Assessment Checklist*" from I.5)	If no stakeholder engagement yet: planned action:	(I.P1) KPI parameter available at least once?	(I.P2 + I.P3) Correctness of KPI parameter verified by:	(I.P4 + I.P5) If necessary: Following data integration for the creation of the missing KPI parameter:	(I.P6) KPI parameter in existent in multiple applications?	(II.A1) List of involved application(s) for the generation of the KPI	(II.A1) If multiple involved applications: applications aligned?	(II.A2) If multiple applications shall remain existent in parallel: which one is the master data?	(II.A3) If multiple non-aligned applications: Integration possible?	(II.A4) If no application/integration available: Acquisition of software necessary/possible?	(I.R1) Reporting need of main stakeholder(s)?	(II.R1) Desired form of reporting already available/in use?	(II.R2) KPI in desired form of reportng already available?	(II.R3) If KPI shall be integrated in existent form of reporting: necessary steps:	(II.R4) If desired reporting is not available yet: necessary steps for the implementation:
Proportion of costs of externally rendered procurement services in %: Costs of externally rendered procurement services / Total costs of rendered procurement services * 100																
Total costs in the subject area of procurement per inpatient case: Total costs in the subject area of procurement / Number of inpatient cases																
Total costs in the subject area of procurement per outpatient case: Total costs in the subject area of procurement / Number of outpatient cases																
Total costs in the subject area of procurement per care day: Total costs in the subject area of procurement / Number of care days																
Total costs in the subject area of procurement in relation to the total costs of the hospital: Total costs in the subject area of procurement / Total costs of the hospital																
Proportion of the goods value of non-medical procurement to the total goods value in the subject area of procurement: Goods value of medical procurement / Total goods value in the subject area of procurement * 100																
Ratio of goods value medical procurement vs. non-medical procurement: Goods value of medical procurement / Goods value of non-medical procurement																
Total costs in the subject area of procurement per number of order item: Total costs in the subject area of procurement / Total number of order items																
Proportion of personnel expenditures in the subject area of procurement to goods value in the subject area of procurement: Personnel expenditures in the subject area of procurement / Goods value in the subject area of procurement																
Average throughput time order processing: Number of effective throughput times of all executed orders / Total number of executed orders																

Appendix 10 – Documentation for Application

The documentation can be viewed and downloaded under www.zhaw.ch/ifm/fm-healthcare/procedure_reference_model or www.projektschrittmacherin.ch

Appendix 11 – Input Document Excel1_Stakeholder_checklist.xlsx

The input document Excel1_Stakeholder_checklist.xlsx can be viewed and downloaded under www.zhaw.ch/ifm/fm-healthcare/procedure_reference_model or www.projektschrittmacherin.ch

Appendix 12 – Input Document Excel2_Status_list.xlsx

The input document Excel2_Status_list.xlsx can be viewed and downloaded under www.zhaw.ch/ifm/fm-healthcare/procedure_reference_model or www.projektschrittmacherin.ch

Appendix 13 – Basis for Interview Guideline: Multi-Perspective Framework for Evaluating Reference Models (Type 3) and Modelling Principles

Consolidation of multi-perspective framework for evaluating reference models (type 3) according to Frank (2007a)

Perspective	*Focus*	*Phase*	*Aspect*
Economic	*Costs*	*Introduction*	*Acquisition*
Economic	*Costs*	*Introduction*	*Training*
Economic	*Costs*	*Introduction*	*Adaptation*
Economic	*Costs*	*Introduction*	*Strategic re-design*
Economic	*Costs*	*Introduction*	*Organisational re-design*
Economic	*Costs*	*Introduction*	*Integration*
Economic	*Costs*	*Transformation and analysis*	*Suitability*
Economic	*Costs*	*Transformation and analysis*	*Tools*
Economic	*Costs*	*Transformation and analysis*	*Training/Support*
Economic	*Costs*	*Maintenance*	*Conceptual support*
Economic	*Costs*	*Maintenance*	*Tools*
Economic	*Costs*	*Maintenance*	*Skills*
Economic	*Benefits*	*Efficiency/effectiveness*	*Software development and maintenance*
Economic	*Benefits*	*Efficiency/effectiveness*	*Business/Management*
Economic	*Benefits*	*Efficiency/effectiveness*	*Business/Management*
Economic	*Benefits*	*Efficiency/effectiveness*	*Business/Management*
Economic	*Benefits*	*Flexibility/integration*	*Dependence from IT-vendors*
Economic	*Benefits*	*Flexibility/integration*	*Openness*
Economic	*Benefits*	*Flexibility/integration*	*Expressive power*
Economic	*Benefits*	*Flexibility/integration*	*Relationship to other IT Artifacts*
Economic	*Coordination/Knowledge management*	*Coordination/knowledge management*	*Coordination*
Economic	*Coordination/Knowledge management*	*Coordination/knowledge management*	*Knowledge management*
Economic	*Investments*	*Protection of investments*	*Spreading/Commitment*
Economic	*Investments*	*Protection of investments*	*Technological change*
Deployment	-	-	*Understandability models (meta, reference, partial)*
Deployment	-	-	*Understandability documentation*
Deployment	-	-	*Appropriateness*
Deployment	-	-	*Attitude*
Engineering	-	-	*Definition*
Engineering	-	-	*Explanation*
Engineering	-	-	*Language features*
Engineering	-	-	*Technical model features*
Epistemological	-	-	*Evaluation of theories*
Epistemological	-	-	*Generic principles*

Epistemological	-	-	*Critical distance*
Epistemological	-	-	*Scientific progress*

Consolidated Modelling Principles
(cf. subsection 3.2.6.4)

Principle of Relevance

- The estimation of the goal and the purpose of orientation is relevant
- The object system or modelled elements are relevant
- All relevant aspects from the real world were selected to be modeled
- The mapping relationships between the real world and the model are relevant
- Model system or the application of the modelling method is relevant

Principle of economic efficiency

The relationship between the cost of the model (development, duration of use, sustainability and flexibility for adaptation without fundamental changes of model) and the benefit (increase in revenue) or reduction of cost by applying the model.

Principle of (formal) correctness

- Syntactic correctness defines the consistency and completeness according to the requirements defined in the meta-model
- Semantic correctness means that the modelling structure and the behaviour is consistent with the real world (homomorphy)
- Semantic consistency are hard to be validated
- Currency are hard to be validated
- Horizontal consistency the consistency on a described level within a model
- Vertical consistency consistency between described levels

Principle of systematic design

The model architecture and the metamodel encompass different compatible perspectives and/or views so that the inter-model consistency of structural and behavioural views and the possibility to integrate different component models in a model is given.

Principle of clarity

- Subjective clarity: if the model is clear to one model user (type)
- Intersubjective clarity: if the model is clear to all model users (user types)
- Clearly structured
- Intuitively understood
- Well readable
- Syntactical simplicity: using as few methodical constructs as necessary)
- Semantic simplicity: depicting of only relevant aspects instead of the complete context including special cases

Principle of comparability

- Recognizability of identities
- The equivalences and compatibilities on the meta-model
- The equivalences and compatibilities on the model layer
- Explicit definition and compliance with conventions
- Consistent use of methods

Principle of construction adequacy

Clear definition and consensus of
- the problem
- the goal of the model usage
- the name conventions
- the content (intention, meaning)
- the scope (extension, totality of the items)

Principle of language adequacy

- The adequacy and problem centredness of a language for the description of a specific context or problem
- The correctness of use of syntax (the syntax has to be defined in the meta-model and complied with in the models; a model is correct, if the language of a model complies with the meta-model)
- The degree of formalization
- The language intelligibility (which depends on the experience of the model user)

Appendix 14 – Derivation of Questions Based on Consolidated Multi-Perspective Framework for Evaluating Reference Models (Type 3) and Modelling Principles

Derivation of questions based on consolidated multi-perspective framework for evaluating reference models (type 3) according to Frank (2007a)

Per-spective	***Focus***	***Aspect***	***Criteria to be evaluated***	**Remarks**	**Questions to be assessed within thesis for procedure reference model**
Economic	*Costs / Introduction*	*Acquisition*	*Cost of purchasing, licensing and inhouse development*	The reference model will be available as open access, therefore no acquisition cost	-
			Economies of scale		-
		Training	*Familiarity of own staff with modelling language/terminology*		How would you assess the need for training in order to apply the model - based on the existing familiartiy with modelling language/terminology in your organisation? - based on the complexity of the model?
			Inhouse modelling expertise		
			Availability of training offers		
			Overall complexity of model		
		Adaptation	*Availability of concepts that support adaptation in a safe and convenient way*		How would you assess the need for adaptation of the model to your organisation?
			Availability and cost of tools for adaptation	n / a	-
			Cost of integrating with existing tools/systems		
		Strategic re-design	*Degree of required change and strategic adaptation*		How high do you assess the need for a strategic re-design in your organisation when applying the model?
		Organisational re-design	*Degree of required change and organisational adaption*		How high do you assess the need for organisational re-design when applying the model?

		Integration	*Degree of required integration with existing models required*	n / a	-
			Degree of required integration with business partners		
			Degree of compatibility of modelling concepts		
	Costs / Transformation and analysis	*Suitability*	*Degree to which modelling concepts allow for automatic transformation into implementation level documents*	n / a	-
			Degree of support of the modelling concept for the required types of analysis		
			If necessary: cost for adapting model for transformation/analysis		
		Tools	*Availability and cost of tools that feature transformation/analysis functions*	n/a	-
			Cost of integrating tool with existing software development environment		
		Training/Support	*Skills required for performing transformation/analysis tasks available*	n / a	-
			Cost of training and external support		
	Costs / Maintenance	*Conceptual support*	*Availability of concepts that support adaptation in a safe and convenient way*		Would you need further conceptual support for further adaptation?
		Tools	*Availability of tools that support model management (versions, users)*		Do you think that using Microsoft Office Programmes is adequate?
			Cost of tools that support model management (versions, users)		
		Skills	*Cost of internal and external skills*		How high do you estimate the effort for internal and/or external skills for the model maintenance?
	Benefits / Efficiency/effectiveness	*Software development and maintenance*	*Degree of improvement of productivity and software quality*	n / a	-

			Degree of functionality of available tools		
			Degree of maturity of available tools		
			Degree of compatibility with existing abstractions		
			Skill level of software developers		
			Degree of willingness to use reference model		
		Business/Manageme nt	*Amount of increased efficiency of affected business processes*		According to your estimation: what would be the biggest benefit(s) when applying the model? How would you assess the - increased efficiency? - cost reduction in the processes? - support for decision scenarios? - improved customer-orientation?
			Amount of cost reduction within business processes		
			Availability of support for specific decision scenarios		
			Familiarity with model based decision making		
			Degree of willingness to use model within decision scenarios		
			Degree of improved customer-orientation		
	Benefits / Flexibility/integrati on	*Dependence from IT-vendors*	*Number of relevant IT-vendors that support model and number of users*	n / a	-
			Degree of customization and standardisation		
			Level of industry commitment		
		Openness	*Degree of compatibility to relevant standards*	n/a	-
			Degree of possibility of integration with further reference models	n/a	-
			Coverage of possible future business models	n/a	-
		Expressive power	*Degree of (ontological) completeness of modelling language*		Do you think the modelling language is complete? If not: what is messing?
		Relationship to other IT Artifacts	*Availability of concepts that foster integration/transformation into other relevant representations*	n/a	-
	Benefits / Coordination/kno	*Coordination*	*Degree of helping to overcome communication barriers within company*		Do you think the model would help to overcome communication

	wledge management		*Degree of fostering communication with external partners to improve coordination of business processes*		barriers - within your organisation? - with external partners? Or even fosters the extablishment of inter-organisational coordination?
			Degree of fostering the establishment of inter-organisational coordination		
		Knowledge management	*Degree of contribution to internal dissemination of relevant knowledge*		Do you think the model would contribute to - the dissemination of relevant knowledge? - cross-organisational exchange of knowledge? - a unified, enterprisewide terminology? - support the development of relevant skills of employees? - support the incorporation of relevant, external knowledge? - support the decrease of time to bring new empoloyees and business partners up to date?
			Degree of contribution to cross-organisational exchange of knowledge		
			Degree of contribution towards a unified, enterprisewide terminology		
			Degree of supporting the development of relevant skills of employees		
			Degree of supporting the incorporation of relevant, external knowledge		
			Degree of supporting the decrease of time to bring new employees and business partners up to date		
	Protection of investments	*Spreading/Commitment*	*Number of organisations that use the model*	Model is freely available, set up with world-wide available Microsoft Office tools and with standardizes notations	-
			Number of vendors and service providers that support the model		
			Degree of standardisation of modelling language		
			Degree of standardisation of model		
		Technological change	*Degree of independence from a particular technology*		
			Degree of supporting technologies that can be expected in near future		
Deployment		*Understandability*	*Degree of elaboration of structure for documentation (e. g., with design patterns)*		Do you think that the documentation of the model is - elaborated enough? - comprehensive?
			Degree of comprehensiveness of documentation		
			Availability of scenarios and examples	n/a	-

			Degree of familiarity with modelling language and terminology		Do you understand - the modelling language? - the terminology?
			Degree of intuitive access to graphical representation		Do you have intuitive access to the graphical representation?
			Availability of views for different groups of stakeholders		Are the views of the different stakeholders given?
		Appropriateness	*Amount of support for purposes relevant for users*		Does the model support your business tasks?
			Degree of support of technologies that can be expected in near future	n/a	-
		Attitude	*Degree of "Not invented here"-syndrome*		How high is the willingness of applying models in general?
			Degree of reputation of model developers		Do you think the context of how the model was developed influences the potential application in your organisation?
			Degree of resistance to organisational change		How high do you estimate the organisational change due to the application of the model in your organisation?
			Degree of resistance to cultural barriers		How high do you estimate the resistance or the cultural barriers to apply the model in your organisation?
Engineering		*Definition*	*Degree of comprehensiveness of description of intended application domains*		Do you think the description of the intended application is comprehensive?
			Degree of comprehensiveness of description of intended purposes		Do you think the description of the intended purpose is comprehensive?
		Explanation	*Degree of assessing model elements to requirements*		Do you think - the model meets the requirements? - the justification of the design decision is given?
			Degree of justification/substantiation of design decisions		
			Degree of discussed design compromises	n/a	-

			Degree of discussed resulting drawbacks	n/a	-
			Degree of discussed alternative approaches	n/a	-
		Language features	*Level of formalization*	BPMN, ERMN are standardized languages	-
			Level of extensibility		Do you think the model could be extended if necessary
			Level of supported conceptual views	model is a conceptual model	-
			Level of integration of views		Do you think it is important to integrate other views? If so: do you think this would be possible in this model?
			Level of tool support	n/a	-
			Level of concepts to support the adaptation of models	n/a	-
			Level of concepts to support the concept to foster model integrity	n/a	-
		Technical model features	*Degree of formal correctness/consistency*		Do you assess the following aspects are given? - formal correctness - consistency - model architecture
			Degree of model architecture		
			Degree of use of classes	n/a	-
			Degree of generalisation/specialisation	n/a	-
			Degree of modularisation/encapsulation	n/a	-
Epistemological		*Evaluation of theories*	*Degree of precision of description of core concepts with respect to corresponding real world concepts*	Validation by Thesis geri	-
			Degree of underlying assumptions	Validation by Thesis geri	-
		Generic principles	*Degree of abstraction*	Validation by Thesis geri	-
			Degree of originality	Validation by Thesis geri	-
			Degree of judgement	Validation by Thesis geri	-
		Critical distance	*Degree of subjective nature*	Validation by Thesis geri	-
			Degree of underlying decisions	Validation by Thesis geri	-

			Degree of bias through familiarity with modelling language	Validation by Thesis geri	-
		Scientific progress	*Availability of discussion of longterm goals of research*	Validation by Thesis geri	-
			Availability of comparison with alternatives	Validation by Thesis geri	-
			Degree of elaboration of documentation of model with respect to generic principles	Validation by Thesis geri	-
			Degree of elaboration of documentation of longterm research goals	Validation by Thesis geri	-

Derivation of questions based on consolidated guidelines of modelling principles (cf. subsection 3.2.6.4)

	Aspect	Remarks	Question
Principle of (formal) correctness	Syntactic correctness: defines the consistency and completeness according to the requirements defined in the meta-model		Is the model consistent according to the meta-model? Is the model complete according to the meta-model?
	Semantic correctness: means that the modelling structure and the behaviour is consistent with the real world (homomorphy)		Is the model consistent with the real-world?
	Semantic consistency	are hard to be validated	-
	Currency	are hard to be validated	-
	Horizontal consistency: the consistency on a described level within a model		Is the consistency within the model given?
	Vertical consistency: consistency between described levels		Is the consistency between the different levels given?
Principle of Relevance	The estimation of the goal and the purpose of orientation is relevant	Relevance clarified in Awareness of Problem iteration	-
	The object system or modelled elements are relevant		Are the modelled elements relevant?
	All relevant aspects from the real world were selected to be modeled		Are all relevant aspects from the real world modeled?
	The mapping relationships between the real world and the model are relevant		Are the mapping relationships between the real world and the model given?

	Model system or the application of the modelling method is relevant	Relevance clarified in Awareness of Problem iteration	-
Principle of economic efficiency	The relationship between the cost of the model (development, duration of use, sustainability and flexibility for adaptation without fundamental changes of model) and the benefit (increase in revenue) or reduction of cost by applying the model		Is the relationship between the cost of the applying the model and the benefit (reduction of cost) given?
Principle of systematic design	The model architecture and the metamodel encompass different compatible perspectives and/or views so that the inter-model consistency of structural and behavioural views and the possibility to integrate different component models in a model is given		Does the model encompass the relevant perspectives? Does the model include the relevant component models?
Principle of clarity	Subjective clarity: if the model is clear to one model user (type)		Is the model clear to you?
	Intersubjective clarity: if the model is clear to all model users (user types)	-> Focus Group	-
	Clearl structure		Is the model clearly structured?
	Intuitively understood		Do you understand the model intuitively?
	Well readable		Do you think the model is well readable?
	Syntactical simplicity: using as few methodical constructs as necessary)		Do you think the model uses as few methodical constructs as necessary?
	Semantic simplicity: depicting of only relevant aspects instead of the complete context including special cases		Do you think the model illustrates only the relevant aspects? If not: which aspects could be dropped?
Principle of comparability	Recognizability of identities	n/a	-
	The equivalences and compatibilities on the meta-model	n/a	-
	The equivalences and compatibilities on the model layer	n/a	-
	Explicit definition and compliance with conventions	n/a	-
	Consistent use of methods	n/a	-
Principle of construction adequacy	Clear definition and consensus of the problem	Problem definition clarified in Awareness of Problem iteration	-

	Clear definition and consensus of the goal of the model usage	Goal definition clarified in Awareness of Problem iteration	-
	Clear definition and consensus of the name conventions	n/a	-
	Clear definition and consensus of the content (intention, meaning)		Is the intention and meaning of the model clear to you?
	Clear definition and consensus of the scope (extension, totality of the items)		Is the scope of the model clear to you?
Principle of language adequacy	The adequacy and problem centredness of a language for the description of a specific context or problem		Do you think the language / notation is adequate?
	The correctness of use of syntax (the syntax has to be defined in the meta-model and complied with in the models; a model is correct, if the language of a model complies with the meta-model)		Is the syntax itself correct? Is the syntax correct according to the meta-model?
	The degree of formalization	ERM & BPMN are standardized	-
	The language intelligibility (which depends on the experience of the model user)		Is the language intelligible to you?

Appendix 15 – Consolidation of Derived Questions, Clustered by Categories

Categories	Questions	Design objective	Epistemic objective
Clarity / Understanability	Do you understand the model intuitively?	x	
	Do you have intuitive access to the graphical representation?	x	
	Is the intention and meaning of the model clear to you?	x	
	Is the scope of the model clear to you?	x	
	Do you think the description of the intended application is comprehensive?	x	
	Do you think the description of the intended purpose is comprehensive?	x	
	Do you think the justification of the design decision is given?	x	
Structure/ Read-ability	Is the model clearly structured?	x	
	Do you think the model is well readable?	x	
Notation	Do you think the language / notation is adequate?	x	
	Do you understand the modelling language?	x	
	Do you think the modelling language is complete?	x	
	Is the syntax itself correct?	x	
	Is the syntax correct according to the meta-model?	x	
Consistency	Do you assess the formal correctness is given?	x	
	Is the model consistent according to the meta-model?	x	
	Is the model consistent with the real-world?	x	
	Is the consistency within the model given?	x	
	Is the consistency between the different levels given?	x	
Exten-dib.	Do you think the model could be extended if necessary	x	
Realistic / Relevance	Are the modelled elements relevant?	x	
	Are all relevant aspects from the real world modeled?	x	
	Does the model support your business tasks?	x	
	Does the model encompass the relevant perspectives?	x	
	Does the model include the relevant component models?	x	
Com-plete-ness	Is the model complete according to the meta-model?	x	
	Are the views of the different stakeholders given?	x	
	Do you think it is important to integrate other views?	x	
Reduced to the max	Do you think the model uses as few methodical constructs as necessary?	x	
	Do you think the model illustrates only the relevant aspects?	x	
Docu-men-tation	Do you think that using Microsoft Office Programme is adequate?	x	
	Do you think that the documentation of the model is elaborated enough?	x	
	Do you think that the documentation of the model is comprehensive?	x	

Organisational mindset	How high is the willingness of applying models in general?		x
	How high do you estimate the resistance or the cultural barriers to apply the model in your organisation?		x
	Do you think the context of how the model was developed influences the potential application in your organisation?		x
Communication	Do you think the model would help to overcome communication barriers within your organisation?		x
	Do you think the model would help to overcome communication barriers with external partners?		x
	Or even fosters the establishment of inter-organisational coordination?		x
	Do you think the model would contribute to support the decrease of time to bring new empoloyees and business partners up to date?		x
	Do you think the model would contribute to a unified, enterprisewide terminology?		x
Knowledge	Do you think the model would contribute to the dissemination of relevant knowledge?		x
	Do you think the model would contribute to cross-organisational exchange of knowledge?		x
	Do you think the model would contribute to support the incorporation of relevant, external knowledge?		x
	Do you think the model would contribute to support the development of relevant skills of employees?		x
Need for training	How would you assess the need for training in order to apply the model based on the existing familiartiy with modelling language/terminology in your organisation?		x
	How would you assess the need for training in order to apply the model based on the complexity of the model?		x
Mainte-nance	How high do you estimate the effort for internal and/or external skills for the model maintenance?		x
Change	How high do you assess the need for a strategic re-design in your organisation when applying the model?		x
	How high do you assess the need for organisational re-design when applying the model?		x
	How high do you estimate the organisational change due to the application of the model in your organisation?		x
Cost-Benefit	Is the relationship between the cost of the applying the model and the benefit (reduction of cost) given?		x
	How would you assess the need for adaptation of the model to your organisation?		x
	Would you need further conceptual support for further adaptation?		x
	How would you assess the increased efficiency?		x
	How would you assess cost reduction in the processes?		x
	How would you assess support for decision scenarios?		x
	How would you assess improved customer-orientation?		x
	Do you think the model meets the requirements?		x
	According to your estimation: what would be the biggest benefit(s) when applying the model?		x

Appendix 16 – Structuring of Questions as Basis for Evaluation

Design objectives assessment -> Expert interviews (first evaluating iteration)

Every Model (metamodel, reference model, component models)

Do you understand the model intuitively? / Do you have intuitive access to the graphical representation? If not: what is confusing?
Is the model clearly structured and well readable? If not: what is not clear?
Is the consistency within the model given? If not: what is not consistent?
Do you think the model could be extended if necessary? If not: why not?
Is the model consistent with the real-world? Are the mapping relationships between the real world and the model given? If not: what has to be added/changed?
Are the modelled elements relevant and are all relevant aspects and perspectives from the real world modeled? If not: what is missing or what should be dropped?
Do you think the model uses as few methodical constructs and aspects as necessary? If not: which aspects could be dropped?
Do you think the language / notation is adequate? / Is the language intelligible to you? / Do you understand the terminology? If not: what is unclear, missing or wrong?

Procedure Reference Model specifically

Is the scope, the intended application and the purpose of the model clear to you? If not: what is unclear?
Is the model consistent and complete and the syntax correct according to the meta-model? If not: what is inconsistent, incomplete or incorrect?
Is the consistency between the different levels given? If not: what is inconsistent?

Component Models specifically

Is the model consistent and complete and the syntax correct according to the meta-model?

Documentation

Do you think that the documentation of the model is comprehensive and elaborated enough? If not: what is missing?
Do you think that using Microsoft Office Programmes (Excel and Visio) for applying the model is adequate? If not: what tools would you suggest?

In-/Output Documents

Do you think that the application of Microsoft Excel is adequate for the input documents?
Is the structure of the input documentclear to you?
Do you think that the input document is complete?
Do you have any observations or comments on the input document ?
Is the structure of the input document clear to you?
Do you think that the input document is complete?
Do you have any observations or comments on the input document?

Epistemic objectives assessment-> focus group discussions (second evaluating iteration)

Decision-making

Do you think the model would support decision-making scenarios?

Customer-orientation

Do you think the model would improve customer-orientation?

Communication

Do you think the model would help to overcome communication barriers within your organisation?
Do you think the model would help to overcome communication barriers with external partners?

Knowledge management

Do you think the model would help to support knowledge management?

Cost-Benefit

How would you assess cost reduction in the processes?
Is the relationship between the cost of the applying the model and the benefit (reduction of cost) given?
How would you assess the need for adaptation of the model to your organisation?

Change

How high do you assess the need for a strategic re-design in your organisation when applying the model?
How high do you assess the need for organisational re-design when applying the model?

Need for training

How would you assess the need for training in order to apply the model based on the existing familiartiy with modelling language/terminology in your organisation?

Need for maintenance

How high do you estimate the effort for internal and/or external skills for the model maintenance?

Benefit

According to your estimation, what would be the greatest benefit(s) when applying the model?

Organisational mindset

Do you think the context of how the model was developed influences the potential application in your organisation?

Appendix 17 – Translation of Qualitative Interview Guideline of the First Iteration in the "Evaluating" Phase

Please note: As the interviews were conducted in the German-speaking part of Switzerland, the original guideline was applied in German (for the discussion of translation issues cf. section 3.4).

Guideline Expert Interviews Evaluation Phase

Thank you very much for your availability and willingness to contribute to my PhD thesis and the development of the domain of ICT in Healthcare!

I have sent you the documentation including the metamodel, the reference model and the process models to be evaluated upfront. Did you have time to go through it?

If so: do you have specific need for clarification? Otherwise, I suggest we go through the interview guideline assessing your inputs and feedbacks.
If not: then let's go through the documentation together before we start with assessing your inputs and feedbacks.

If you do not wish to answer one of the questions, we can skip it and if you feel like interrupting or aborting the interview, you can indicate so at any time.

The content of the guideline follows the research done by Frank, U. (2007) Evaluation of Reference Models In: Reference Modeling für Business Systems Analysis. Fettke, Peter; Loos, Peter (eds.) Hershey: IDEA Group Publishing as well as Schütte, Reinhard (1998) Grundsätze ordnungsmässiger Referenzmodellierung – Konstruktion konfigurations- und anpassungsorientierter Modelle. Wiesbaden: Gabler.

The interview consists of three parts:
1 the models: metamodel, procedure reference model, component model
2 the documentation
3 the input documents

We start the evaluation with the assessment of your impression about the model with its component models. First, we will look at the **metamodel**.

1.1 Do you intuitively understand the model? Do you have intuitive access to the graphical representations?
☐ Yes
☐ No: What is not clear?
Comment:

1.2 According to your opinion, is the model well-structured and easily readable?
☐ Yes
☐ No: What is not clear?
Comment:

1.3 Do you think that the chosen notation / modelling language is adequate? Is the notation understandable and do you understand the terminology?
☐ Yes
☐ No: What is unclear, missing or wrong?
Comment:

1.4 Do you think that the consistency within the model is given?
☐ Yes
☐ No: What is not consistent?
Comment:

1.5 Do you think the model could be extended if necessary?
☐ Yes
☐ No: Why not?
Comment:

1.6 Does the model, according to your opinion, correspond to the real world in practice? Are the relationships within the model realistic?
☐ Yes
☐ No: What should be added or changed?
Comment:

1.7 Are the modelled elements according to your opinion relevant and/or are all relevant aspects and perspectives from the real world present in the model?
☐ Yes
☐ No: What is missing or should be omitted?
Comment:

1.8 Do you think that the depicted areas and aspects in the model are reduced to the max?
☐ Yes
☐ No: What aspects should be omitted?
Comment:

Let's now look at the **procedure reference model**.

2.1 According to your opinion, are the scope, the intended application and the goal of the model clear?
☐ Yes
☐ No: What is not clear?
Comment:

2.2 Do you intuitively understand the model? Do you have intuitive access to the graphical representations?
☐ Yes
☐ No: What is not clear?
Comment:

2.3 According to your opinion, is the model well-structured and easily readable?
☐ Yes
☐ No: What is not clear?
Comment:

2.4 Do you think that the chosen notation / modelling language is adequate? Is the notation understandable and do you understand the terminology?
☐ Yes
☐ No: What is unclear, missing or wrong?
Comment:

2.5 Is the model according to your opinion consistent and the syntax according to the metamodel correct?
☐ Yes
☐ No: What is unclear, missing or wrong?
Comment:

2.6 Do you think that the consistency within the model is given?
☐ Yes
☐ No: What is not consistent?
Comment:

2.7 According to your opinion, is the consistency between the different levels given?
☐ Yes
☐ No: What is not consistent?
Comment:

2.8 Do you think the model could be extended if necessary?
☐ Yes
☐ No: Why not?
Comment:

2.9 Does the model, according to your opinion, correspond to the real world in practice? Are the relationships within the model realistic?
☐ Yes
☐ No: What should be added or changed?
Comment:

2.10 Are the modelled elements according to your opinion relevant and/or are all relevant aspects and perspectives from the real world present in the model?
☐ Yes
☐ No: What is missing or should be omitted?
Comment:

2.11 Do you think that the depicted areas and aspects in the model are reduced to the max?
☐ Yes
☐ No: What aspects should be omitted?
Comment:

Let's now look at the **component model**.

3.1 Do you intuitively understand the model? Do you have intuitive access to the graphical representations?
☐ Yes
☐ No: What is not clear?
Comment:

3.2 According to your opinion, is the model well-structured and easily readable?
☐ Yes
☐ No: What is not clear?
Comment:

3.3 Do you think that the chosen notation / modelling language is adequate? Is the notation understandable and do you understand the terminology?
☐ Yes
☐ No: What is unclear, missing or wrong?
Comment:

3.4 Is the model according to your opinion consistent and the syntax according to the metamodel correct?
☐ Yes
☐ No: What is unclear, missing or wrong?
Comment:

3.5 Do you think that the consistency within the model is given?
☐ Yes
☐ No: What is not consistent?
Comment:

3.6 Do you think the model could be extended if necessary?
☐ Yes
☐ No: Why not?
Comment:

3.7 Does the model, according to your opinion, correspond to the real world in practice? Are the relationships within the model realistic?
☐ Yes
☐ No: What should be added or changed?
Comment:

3.8 Are the modelled elements according to your opinion relevant and/or are all relevant aspects and perspectives from the real world present in the model?
☐ Yes
☐ No: What is missing or should be omitted?
Comment:

3.9 Do you think that the depicted areas and aspects in the model are reduced to the max?
☐ Yes
☐ No: What aspects should be omitted?
Comment:

Let us continue with assessing the **documentation of the model**.

4.1 Do you think that the model documentation is comprehensible in general?
☐ Yes
☐ No: What is unclear/missing?
Comment:

4.2 Do you think that the model documentation is precise and justified enough?
☐ Yes
☐ No: What is unclear/missing?
Comment:

4.3 Do you think that the use of Microsoft Office Visio for the application of the model is adequate?
☐ Yes
☐ No: What else would you suggest instead?
Comment:

To conclude with, let's assess at **input documents of the model**.

5.1 Do you think that the application of Microsoft Excel is adequate for the input documents?
☐ Yes
☐ No: What else would you suggest instead?
Comment:

5.2 Is the structure of the input document "KPI_Stakeholder_Assessment_Checklist.xlsx" clear to you?
☐ Yes
☐ No: What is unclear/missing?
Comment:

5.3 Do you think that the input document "KPI_Stakeholder_Assessment_Checklist.xlsx" is complete?
☐ Yes
☐ No: What is missing?
Comment:

5.4 Do you have any observations or comments on the input document "KPI_Stakeholder_Assessment_Checklist.xlsx"?
☐ No
☐ Yes, namely:

5.5 Is the structure of the input document "Record_for_analysis+specification_(template)" clear to you?
☐ Yes
☐ No: What is unclear/missing?
Comment:

5.6 Do you think that the input document "Record_for_analysis+specification_(template)" is complete?
☐ Yes
☐ No: What is missing?
Comment:

5.7 Do you have any observations or comments on the input document "Record_for_analysis+specification_(template)"?
☐ No
☐ Yes, namely:

Thank you very much for your time and your expertise!

After conducting all the expert interviews, I'll update the model according to the findings. It will then once again be evaluated. With your permission, I will contact you again – maybe you'll be able to contribute one last time to this project.

In any case: I will provide you with the output of my research if you are interested – just let me know.

Appendix 18 – Extract of Example of Anonymized Interview Transcript of Interview in the First Iteration of the "Evaluating" Phase

Please note: As the interviews were conducted with German-speaking experts, the interviews were held and recorded in German; for documentation reasons within this thesis, the transcripts were translated into English (for the discussion of translation issues cf. section 3.4).

Transcript 4 Expert Interviews Evaluation Phase
[…]
NG: Do you intuitively understand the model? Do you have intuitive access to the graphical representations? [2.2]
I: I don't know this notation and it wasn't very easy to me to understand. But thinking about it I think it is clear.

NG: According to your opinion, is the model well-structured and easily readable? [2.3]
I: Yes.

NG: Do you think that the chosen notation / modelling language is adequate? Is the notation understandable and do you understand the terminology? [2.4]
I: I personally haven't used it in detail. But it is a known notation so I think it is good.

NG: Is the model according to your opinion consistent and the syntax according to the meta-model correct? [2.5]
I: The question about the Transaction has to be checked and my question is, where the Process is in the model – I think there should be a representation of this.
I doubt if the statement that it is possible to enter in any point is correct. I believe there is a logical, sequential procedure to be followed in order to succeed.

NG: Do you think that the consistency within the model is given? [2.6]
I: Yes but noting again that I'm not sure if the arrows can be applied as easily as illustrated here. If this is the case, then it is consistent in my opinion.

NG: According to your opinion, is the consistency between the different levels given? [2.7]
I: I think so.

NG: Do you think the model could be extended if necessary? [2.8]
I: Yes, I like this.

NG: Does the model, according to your opinion, correspond to the real world in practice? Are the relationships within the model realistic? [2.9]
I: Yes I think so. The question is, how much effort would it need and what else should be added.

NG: Are the modelled elements according to your opinion relevant and/or are all relevant aspects and perspectives from the real world present in the model? [2.10]
I: Yes it makes sense.

NG: Do you think that the depicted areas and aspects in the model are reduced to the max? [2.11]
I: Yes, I think so.

NG: Let's now look at the component model. Do you intuitively understand the model? Do you have intuitive access to the graphical representations? [3.1]
I: Yes.

NG: According to your opinion, is the model well-structured and easily readable? [3.2]
I: Yes – if the symbols of Transaction and Process are corrected.

NG: Do you think that the chosen notation / modelling language is adequate? Is the notation understandable and do you understand the terminology? [3.3]
I: Yes

NG: Is the model according to your opinion consistent and the syntax according to the meta-model correct? [3.4]

I: I saw, that in 2.4.2.1 there is a “No” missing on the arrow between step II.R4 and the end. But other than that I found no errors.

NG: Do you think that the consistency within the model is given? [3.5]
I: Yes

NG: Do you think the model could be extended if necessary? [3.6]
I: Yes

NG: Does the model, according to your opinion, correspond to the real world in practice? Are the relationships within the model realistic? [3.7]
I: At first sight, I think so. How it specifically would be implemented is another question.

NG: Are the modelled elements according to your opinion relevant and/or are all relevant aspects and perspectives from the real world present in the model? [3.8]
I: Yes, I think so.

NG: Do you think that the depicted areas and aspects in the model are reduced to the max? [3.9]
I: Yes.

NG: Let us continue with assessing the documentation of the model. Do you think that the model documentation is comprehensible in general? [4.1]
I: Yes it is comprehensible. What I had trouble with is the notation where I had to go back and forth.

NG: Do you think that the model documentation is precise and justified enough? [4.2]
I: I would have liked more indication about goal and objectives of it all. In the beginning it was hard for me to get into the subject, the whole context, what’s the goal. So the derivation of it would have helped me. If someone has no clue about it, it would be difficult to orient themselves.

NG: Do you think that the use of Microsoft Office Visio for the application of the model is adequate? [4.3]
I: It is good as a widespread software.

NG: To conclude with, let’s assess at input documents of the model. Do you think that the application of Microsoft Excel is adequate for the input documents? [5.1]
I: Yes, it’s good.

NG: Is the structure of the input document “KPI_Stakeholder_Assessment_Checklist.xlsx” clear to you? [5.2]
I: Once I got into it, it was comprehensible. Particularly the interlink between the two documents. In the beginning, I wasn’t sure about the connection of the two documents. But afterwards it became clear.

NG: Do you think that the input document “KPI_Stakeholder_Assessment_Checklist.xlsx” is complete? [5.3]
I: Yes, I think there is already a lot on it. However, when applying it, I would reduce the things that I wouldn’t need or expand it in an area when necessary. A grouping function within Excel could support that. But I think to have the overall spectrum is good like that. Handling the Excel will then depend on the skills of the individual user.

NG: Do you have any observations or comments on the input document “KPI_Stakeholder_Assessment_Checklist.xlsx”? [5.4]
I: No

NG: Is the structure of the input document “Record_for_analysis+specification_(template)” clear to you? [5.5]
I: I see that all comes together in this file. However, in the beginning it was hard to understand how the different steps come together. But I don’t know how it could be done in an easier way. Because once it becomes clear, it is comprehensive. The abbreviations were sometimes a bit confusing in the beginning. But bringing the whole thin together is complex and I wouldn’t know how to make it simpler because otherwise something would be missing. But one has to be aware that it takes some time to dive in. It think it would be interesting to have specific, simple example which goes through the different documents and steps so it is visible, what the whole context is. But I would leave it all together as it is now.

NG: Do you think that the input document “Record_for_analysis+specification_(template)” is complete? [5.6]
I: I think so. The essential thing is that it has to be done in practice.

[…]

Appendix 19 – A Priori Categories Applied for Analysis in the First Iteration of the "Evaluating" Phase, Clustered by Artefacts

1 Metamodel

1.1 Understandability/intuitive access

1.2 Structure/Readability

1.3 Adequacy of notation/modelling language

1.4 Consistency within the model

1.5 Extensibility

1.6 Realistic/Correspondence to real world practice

1.7a Relevance

1.7b Completeness

1.8 Reduced to the max

2 Procedure Reference Model

2.1 Clarity of scope and goal

2.2 Understandability/intuitive access

2.3 Structure/Readability

2.4 Adequacy of notation/modelling language

2.5 Consistency of syntax with metamodel

2.6 Consistency within the model

2.7 Consistency between the levels

2.8 Extensibility

2.9 Realistic/Correspondence to real world practice

2.10a Relevance

2.10b Completeness

2.11 Reduced to the max

3 Component Models

3.1 Understandability/intuitive access

3.2 Readability

3.3 Adequacy of notation/modelling language

3.4 Consistency of syntax with metamodel

3.5 Consistency

3.6 Extensibility

3.7 Realistic/Correspondence to real world practice

3.8a Relevance

3.8b Completeness

3.9 Reduced to the max

4. Documentation

4.1 Comprehensibility

4.2 Precision/Justification

4.3 Adequacy of Microsoft Office Visio

5. Input Documents

5.1 Adequacy of Microsoft Office Excel

Input document Excel 1

5.2 Clarity

5.3 Completeness

5.4 Observations

Input document Excel 2

5.5 Clarity

5.6 Completeness

5.7 Observations

Appendix 20 – Codes Applied During Qualitative Analysis in the First Iteration of the "Evaluating" Phase

Please note: Based on the translated interview transcripts and again for documentation reasons, the analysis and the coding were conducted in English (for the discussion of translation issues cf. section 3.4).

Dokumente	**430**
Transcript 1	**65**
Transcript 2	66
Transcript 3	51
Transcript 4	53
Transcript 5	44
Transcript 6	45
Transcript 7	62
Transcript 8	44

- Codesystem
  - 1 Metamodel
    - 1.1 Understandability/intuitive access given
    - 1.2 Structure/Readability given
    - 1.3 Adequacy of notation/modelling language given
    - 1.4 Consistency given
    - 1.5 Extensibility given
    - 1.6 Realistic/Correspondence to real world practice given
    - 1.7a Relevance given
    - 1.7b Completeness given
    - 1.8 Reduced to the max
  - 2 Procedure Reference Model
    - 2.1 Clarity of scope and goal given
    - 2.2 Understandability/intuitive access given
    - 2.3 Structure/Readability given
    - 2.4 Adequacy of notation/modelling language given
    - 2.5 Consistency of syntax with metamodel given
    - 2.6 Consistency within the model given
    - 2.7 Consistency between the levels given
    - 2.8 Extensibility given
    - 2.9 Realistic/Correspondence to real world practice given
    - 2.10a Relevance given
    - 2.10b Completeness given
    - 2.11 Reduced to the max
  - 3 Component Models
    - 3.1 Understandability/intuitive access given
    - 3.2 Readability given
    - 3.3 Adequacy of notation/modelling language given
    - 3.4 Consistency of syntax with metamodel given
    - 3.5 Consistency given
    - 3.6 Extensibility given
    - 3.7 Realistic/Correspondence to real world practice given
    - 3.8a Relevance given
    - 3.8b Completeness given
    - 3.9 Reduced to the max
  - 4 Documentation
    - 4.1 Comprehensibility given
    - 4.2 Precision/Justification given
    - 4.3 Adequacy of Microsoft Office Visio given
  - 5. Input Documents
    - 5.1 Adequacy of Microsoft Office Excel given
    - Input document Excel 1
      - 5.2 Clarity of structure given
      - 5.3 Completeness of document given
      - 5.4 Observations
    - Input document Excel 2
      - Missing awareness of benefit: not easy to fill in
      - 5.5 Clarity of structure given
      - 5.6 Completeness of document given
      - 5.7 Observations

List of Codes	#
	430
1 Metamodel	0
1.1 Understandability/intuitive access given	8
Check understandability of Attribute, Iteration and Transaction	1
Check necessity for documentation for practical application	2
Model knowhow necessary	1
Focus to understand needed	1
Time to understand needed	2
1.2 Structure/Readability given	8
1.3 Adequacy of notation/modelling language given	7
Check about two-directed ERM notation	1
Check if both in BPMN	1
No experience with ERM	1
1.4 Consistency given	8
"Transaction" not clear	3
1.5 Extensibility given	7
Check indication who would extend	1
1.6 Realistic/Correspondence to real world practice given	3
For complex processes	1
Should be tested in practice	1
Not for all hospital stakeholders	1
Depending on effort-benefit situtaion	1
Not in current practice	3
IT not in the lead	1
Late involvement of IT	2
Little documentation	1
No good documentation tools	1
No time to document	1
It would be good in an ideal world	4
1.7a Relevance given	8
For software evaluation	1
Basis for common understanding for discussions/developments	1
Documentation possibility	1
1.7b Completeness given	7
1.8 Reduced to the max	7
2 Procedure Reference Model	0
2.1 Clarity of scope and goal given	5
Importance and time need has to be clear	1
Combination with documentation good	2
Benefit of it not very clear	2
Time to read/understand needed	2
2.2 Understandability/intuitive access given	6
Check indication of In-/Output documents being Excels	1
Scenarios would help for practical application	1
Check indication of starting point	1

Check 3D model illustration	1
Consistent colours would help	2
Ensure visibility when printed in b/w	1
Examples of scenarios would be good	1
Check if really no specific starting point + specific procedure	2
Together with documentation	2
2.3 Structure/Readability given	7
Use room of sheet better	1
Text should be more dominant than lines	1
Check better visibility of IDs	1
Text of component models should be readable at least when zoomi	2
Switching between Excel and model difficult	1
ID abbreviations not explained enough / should be improved	2
Differentiation I as letter and Roman number	1
2.4 Adequacy of notation/modelling language given	8
2.5 Consistency of syntax with metamodel given	5
Check representation of "Process"	1
Check notation of Transactoin	3
2.6 Consistency within the model given	7
Check notation for arrows for association	1
Check indicated freedom of procedure as indicated by arrows	1
Check definition of "Activity"	1
Check "process" in legend	1
2.7 Consistency between the levels given	6
Has to be rechecked after corrections	1
2.8 Extensibility given	8
2.9 Realistic/Correspondence to real world practice given	7
Should be tested in practice	1
The question is the effort-benefit relationship	1
IT involved too late	2
Missing awareness of IT involvement	1
Not in current practice	5
In small contexts steps are summarised	1
In ideal world systematical applicatoin	3
2.10a Relevance given	7
2.10b Completeness given	7
2.11 Reduced to the max	7
Reduce In-/Output document text	1
Check dropping lines if possible or show them thinner	1
Check dropping of in-/output docu symbol in process illustratio	1
3 Component Models	0
3.1 Understandability/intuitive access given	7
Time needed to get into context	1
3.2 Readability given	8
3.3 Adequacy of notation/modelling language given	7
3.4 Consistency of syntax with metamodel given	7
“No” missing on the arrow between step II.R4 and the end	1

Check notation of Transaction, Activity + Process	2
3.5 Consistency given	7
Check start describing with Stakeholders in both iterations	1
3.6 Extensibility given	7
3.7 Realistic/Correspondence to real world practice given	8
Helps to ask the right questions	1
Some theoretical background is necessary	1
One has to be aware of the workload	1
Realistic for bigger projects	1
3.8a Relevance given	8
The process needs time and might trigger more questions	1
3.8b Completeness given	7
3.9 Reduced to the max	8
4 Documentation	0
4.1 Comprehensibility given	7
Important to address the correct profiles to read it	1
Back and forth for notation	1
Quick guide not helpful / too short	1
Spelling mistakes	1
4.2 Precision/Justification given	7
Indication about effort-benefit relationship / future gain	1
Quick introduction with main idea and context would be helpful	1
Has to reduce the psychological barrier to the context	1
More information about goal/objectives	2
Indication of involvement of Controlling would be helpful	1
Explanation of KPIs with examples needed	1
4.3 Adequacy of Microsoft Office Visio given	8
Option: html based website	1
Check features of MindJet Manager	1
Drill down possibility / linked content would be good	1
Check mouse roll-over feature for explanations or links	1
5. Input Documents	0
5.1 Adequacy of Microsoft Office Excel given	8
Automatisation of documents	1
Input document Excel 1	0
5.2 Clarity of structure given	8
Underline for main stakeholder -> improve e.g. with asterisk	2
Help about abbreviations would be helpful	1
Comments in first line for indications	1
Documentation needed for explanation about KPIs	1
Colour legend not intuitively understood	2
5.3 Completeness of document given	8
5.4 Observations	0
Handling depends on Excel knowhow of user	1
Legends on top good	1
Check grouping function for reduced complexity without deleting	3
Check all links	1

Not for "everybody"	1
Definition of super users / savvy document owners	2
Input document Excel 2	0
Missing awareness of benefit: not easy to fill in	1
5.5 Clarity of structure given	6
Complex and confusing	1
Check merging cells functions	1
Check applicaiton of consistent colours for clarification	4
Check clear indication that this is where it all comes together	1
Check support about abbreviaitons	1
Check introduction of legend	1
Check conversion of lines and columns	1
Check clustering/grouping function	3
Check clustering possibilities for specific stakeholders	1
Check separate areas in different tables	1
5.6 Completeness of document given	6
Indication on how to adjust comment cells in Excel	1
Check specific marking of fields with comments	1
5.7 Observations	0
Check possibility to interlink Excels	1
Has to be done in practice - needs time an dedication	2
Clever grouping rather than partitioning the sheets	2
Has to be printable on A3	1
Verification of context as an overview	1

Appendix 21 – Material Processing in the First Iteration of the "Evaluating" Phase

Material Processing Metamodel

Evaluation	Indicated Corrections	Mentioned Improvements	Mentioned "Nice to haves"
Intuitive understanding / intuitive access to the graphical representation?	- Change "Transaction" to "Grouping"	- Explain terms Attribute, Iteration and Transaction more clearly	
Clear structure and good readability?	- Include aspect of "(Sub-)Process" in model		
Consistency within model?	- Align use of "Activity"		
Extendibility of model?			- Indicate when extension makes sense and by whom
Consistency with real-world?			
Relevance?		- Use metamodel documentation only as background information	
Reduction to the max?			
Adequacy of modelling language?			- Two-directed ERM notation

Material Processing Procedure Reference Model

Evaluation	Indicated Corrections	Mentioned Improvements	Mentioned "Nice to haves"
Intuitive understanding / intuitive access to the graphical representation?	- Change "Transaction" to "Grouping"	Introduce consequent colours Add indication of starting point if adequate	Clearer differentiation between I as letter and I as Roman number Easier connection between Excels and documentation
Clear structure and good readability?	Include aspect of "(Sub-)Process" in model	Reduce in-/output text to get more space Indicate that in-/output documents are Excels Use room of sheet better Make lines less dominant than text Give more visibility for IDs Check introduction of arrow heads for association lines Readibility of component model text when zooming in	3D illustration
Consistency within model?	Align use of "Activity"		
Extendibility of model?			Indicate when extension makes sense and by whom
Consistency with real-world?			
Relevance?			
Reduction to the max?		Check possibility of dropping lines Drop in-/output symbol in sub-process illustration	
Adequacy of modelling language?			
Scope / intended application clear?		Explain and show intended goals / objectives and benefit better.	
Consistency / completeness according to metamodel?			
Consistency between different levels given?			

Material Processing Component Models

Evaluation	Indicated Corrections	Mentioned Improvements	Mentioned "Nice to haves"
Intuitive understanding / intuitive access to the graphical representation?		Use consequent colours	
Clear structure and good readability?		Give more visibility for IDs	
Adequacy of modelling language?			
Consistency with metamodel	Align use of "Activity" also in tables “No” missing on the arrow between step II.R4 and the end		
Consistency within model?		Use the same documentation order in both iterations (stakeholders first etc.)	
Extendibility of model?			Indicate when extension makes sense and by whom
Consistency with real-world?			
Relevance?			
Reduction to the max?		Check possibility of dropping lines Drop in-/output symbol in sub-process illustration	
Adequacy of modelling language?			
Consistency / completeness according to metamodel?			

Material Processing Documentation

Evaluation	Indicated Corrections	Mentioned Improvements	Mentioned "Nice to haves"
Understandibility?		Extend quick guide in the sense of an overview of it all Distinguish between Application Information and Background Information Add clear descprition with Excel 2 indicating that this is where it all comes together Introduce scenario examples and add indication of corresponding starting points and the roles (specifically of Controlling) Explain logic of IDs more prominently / give ID overview Add KPI examples in text	Design documentation as to reduce psychological barrier of the complex context Check possibility to avoid having to go back and forth for the notation
Precision and Justification given?		Explain benefit and objectives/goals of model (application) more clearly Indicate the relevance also for software evaluation, basis for common understand for discussions and development and as a documentation tool Indication that time is needed if model is applied; indication of effort-benefit situation Show illustration of overview including the Excels	Use for argumentation / enabling IT as important driver (IT is currently often not in the lead, is involved late and isn't used to good documentation) Establish model as applicable tool for systematic procedure and documentation managed by IT
Adequacy of Microsoft Office Visio?			
Additional comments	Include corrections made in models Check for spelling mistakes	Try to add drill down possibilities or at least link content more	html based website Features like in MindJet Manager Mouse roll-over feature for explanations or for links

Material Processing Input Documentation

Evaluation	Indicated Corrections	Mentioned Improvements	Mentioned "Nice to haves"
Adequacy of Microsoft Office Excel?			
Clear structure?		Introduce grouping function, enable further clustering Apply colors corresponding to model	Mark fields with comments or dropdown possibilities Check further merging possibilities of cells
Completeness?		Introduce legend / comments for explanations also in Excel 2 Introduce more indications about KPI background in Excel 2	
Observations?	Exchange underline for main stakeholder with other symbol (e.g. asterisk) Verify correctness of all links	Interlink Excels Introduce indication on how to adjust comment cells in Excel	Automatisation of documents

Material Processing Overall

Overall indications by experts
Clarify target group / profiles of model/documentation: not for everybody but specific model savvy specialists (PM, IT expert)
The model should also be applicable for small contexts, by enabling summarizing steps
Total "package" should be tested in practice
A detailed scruitinizing assessment would be desired, but it is not the current practice in hospitals
Combination of model with documentation is good and necessary
Consistent colours in the model, the Excels and the documentations have to be introduced, keeping in mind b/w printouts
Helps to ask the right questions - awareness that process might trigger more questions
Combination of theory and practice seems well-received

Appendix 22 – Translation of the Interview Guideline in the Second Iteration of the "Evaluating" Phase

Please note: As the Focus Group discussions were conducted with German-speaking experts, they were held and recorded in German; for documentation reasons within this thesis, the transcripts were translated into English (for the discussion of translation issues cf. section 3.4).

Guideline for Focus Group discussion

1. General model application
1.1 Do you think the model would support decision-making with respect to implementing key performance indicators?
How? / Why not? / Comments?

1.2 Do you think the model would support the decision-making with respect to the reporting of key performance indicators?
How? / Why not? / Comments?

1.3 Do you think the model would support the decision-making about the alignment of applications?
How? / Why not? / Comments?

1.4 Do you think the model would support another decision scenario?
Yes, namely:

1.5 Do you think the model would improve customer-orientation?
How? / Why not? / Comments?

1.6 Do you think the model would help to foster internal and/or external communication?
How? / Why not? / Comments?

1.7 Do you think the model would help to support knowledge management?
How? / Why not? / Comments?

1.8 Do you think the model would contribute to cost reduction in the processes?
How? / Why not? / Comments?

1.9 According to your estimation, what would be the greatest benefit(s) when applying the model?
Benefits? Comments?

2. for specific model application
2.1 How high do you assess the need for a strategic re-design in your organisation when applying the model?

☐ Low need ☐ Moderate need ☐ High need ☐ I don't know

Comment(s):

2.2 How high do you assess the need for organisational re-design when applying the model?

☐ Low need ☐ Moderate need ☐ High need ☐ I don't know

Comment(s):

2.3 How would you assess the need for training if you were to implement the model in your context?

☐ Low need ☐ Moderate need ☐ High need ☐ I don't know

2.4 How would you assess the need for adaptation of the model if you were to apply the model in your context?

☐ Low need ☐ Moderate need ☐ High need ☐ I don't know

Comment(s):

2.5 How high do you estimate the internal and/or external effort required in your context for the model maintenance if you were to apply the model?

Low effort	Moderate effort	High effort	I don't know
☐	☐	☐	☐

Comment(s):

2.6 How would you assess the relation between effort and benefit when applying the model?

Effort > Benefit	Effort = Benefit	Effort < Benefit	I don't know
☐	☐	☐	☐

Comment(s):

2.7 Do you think the context of how the model was developed (in the context of a PhD thesis) would influence the potential application in your context?

☐ Yes, namely:
☐ No, because:
Comment(s):

2.8. Would you like to add something else?

Appendix 23 – Extract of one Anonymized Transcript of the Focus Group Discussions in the Second Iteration of the "Evaluating" Phase

[…]
NG: Do you think the model would help to foster internal and/or external communication?
ICT: I definitively say yes.
Controlling 2: Yes.
ICT: Once you sit on a table, when you know your stakeholders, then I can ask them what is useful for them on this basis.

NG: Do you think the model would help to support knowledge management?
ICT: Well I think, it's one beginning point.
Controlling 1: Yes.
ICT: I think with the model, how it's described, a lot of things can be done with it. Be it the generation of KPIs, whatever. But the structured procedure I find good!
Controlling 1: Yes that's good.
ICT: That I can repeat things: first one topic, then another topic.
Controlling 2: Yes I think so.

NG: Do you think the model would contribute to cost reduction in the processes (even though this wasn't the main focus of the model development)?
Controlling 1: Yes, I can imagine that it can help. It forces people to think about processes, procedures. Therefore.
ICT: I believe that it leads to it directly or indirectly. Directly because many people simply don't know what their process costs and then maybe are surprised saying "if I had known that, then I would have maybe done something else". If we get more transparent and visible, we might suddenly see aspects that we haven't seen before.
Controlling 1: Yes, the awareness of things: "Oh I haven't thought about that".
ICT: Yes exactly. Like not getting as many externals for example.
Controlling 1: This can be done when the people get involved, asking the right questions.
ICT: In project management, we say, make the affected people involved people. That's for sure the topic. When the are involved and can follow the whole process from A to B to C and when they are accompanied, then they don't just get a numbers in their face, but seeing: that's us, there are other people involved.
Controlling 1: Exactly
ICT: So they know how are the numbers composed, what are the parameters, where are the adjustment possibilities. I think this is great. And this is why I'm sure this will lead to cost reduction.
Controlling 1: I think so too
Controlling 2: Yes.

NG: According to your estimation, what would be the greatest benefit(s) when applying the model?
ICT: I see two aspects: as I said involving the people affected, also called stakeholder management, that's one of the big benefits. But also, that it leads to an overall overview: where do I get which data and how to I compose them. So the overview overall is one of the big benefits.
Controlling 1: I find the structured procedure is a benefit. Away from "just do something no". And in the end as a basis for discussion if this was the right thing to do. So the structured procedure would help us.

NG: Just to make sure: do you think that the structure is pragmatic and applicable?
Controlling 1: Yes, it is not too complicated.

ICT: Yes, I find it pragmatic. And also freed from unnecessary frills, reduced to the most important facts.
Controlling 1: Exactly

NG: How high do you assess the need for a strategic re-design in your organisation when applying the model?
Controlling 1: I think it can be applied in daily business, in the operational area.
ICT: It wouldn't need much adaptation as you have done the big step with the MIS already. So that exists already. There is therefore not much need for strategic steps.
Controlling 1: Yes
Controlling 2: Well to ask about the needs and requirements.
[…]

Appendix 24 – A Priori Categories Applied for Analysis in the Second Iteration of the "Evaluating" Phase

1. General model application

1.1 Contribution of decision-making support for KPI implementation

1.2 Contribution of decision-making support for KPI reporting

1.3 Contribution of decision-making support for application alignment

1.4 Contribution of decision-making support for other application

1.5 Contribution to improve customer-orientation

1.6 Contribution to Internal/external communication

1.7 Contribution to knowledge management

1.8 Contribution to cost reduction in processes

1.9 Greatest benefits of model application

2. Specific model application

2.1 Need for strategic re-design for model application

2.2 Need for organisational re-design for model application

2.3 Need for training for model application

2.4 Need for model adaptation

2.5 Need for internal/external model maintenance effort

2.6 Effort-benefit-relationship when applying model

2.7 Influence of model development context (PhD thesis)

2.8 other model application possibilities

2.9 Other aspects about the model

Appendix 25 – Codes Applied During Qualitative Analysis of the Second Iteration the in "Evaluating" Phase

Dokumente	256
Transcript 1	57
Transcrip 2	77
Transcript 3	63
Transcript 4	59

Codesystem

- 1.1 Contribution of decision-making support for KPI implement.
- 1.2 Contribution of decision-making support for KPI reporting
- 1.3 Contribution of decision-making support for appl. alignment
- 1.4 Contribution of decision-making support for other appl.
- 1.5 Contribution to improve customer-orientation
- 1.6 Contribution to Internal/external communication
- 1.7 Contribution to knowledge management
- 1.8 Contribution to cost reduction in processes
- 1.9 Greatest benefits of model application
- 2.1 Need for strategic re-design for model application
- 2.2 Need for organisational re-design for model application
- 2.3 Need for training for model application
- 2.4 Need for model adaptation
- 2.5 Need for internal/external model maintenance effort
- 2.6 Effort-benefit relationship when appl. model
- 2.7 Influence of model development context (PhD thesis)
- 2.8. Other model application possibilities
- 2.9 Other aspects about the model

Liste der Codes	#
Codesystem	256
1.1 Contribution of decision-making support for KPI implement.	0
utile for decision-making support for KPI implementation	3
for stakeholder involvement/management	3
for (dynamic) parametrisation	1
for personal identification with KPIs	1
for the discussion about the right KPIs	1
for assessment of the stakeholders and their context	1
partially utile for decision-making support for KPI impl.	2
would be utile but current culture would overrun the idea	1
if the overal goal/strategic mission is clear	2
not utile for decision-making support for KPI implementation	1
not for definition of correct/crucial/really necessary KPIs	4
no estimation possible	3
1.2 Contribution of decision-making support for KPI reporting	0
utile for decision-making support for KPI reporting	2
for (iterative) discussion of reporting form	2
for awareness of different stakeholders + their reporting needs	1
partially utile for decision-making support for KPI reporting	2
suggestion about best presentation is not provided	1
would be utile but culture would overrun the idea	0

no estimation possible	1
1.3 Contribution of decision-making support for appl. alignment	0
utile for contribution of decision-making support for appl. alig	7
for harmonisation	2
to ensure common understanding	1
to talk about functionalities not products	2
to rank applications	1
to handle interfaces	1
to know details about parameters	1
for a structured process	2
for proactive / transparent planning	2
1.4 Contribution of decision-making support for other appl.	0
to determine penetration rate	1
to determine degree of standardisation of applications/solutions	1
to define staff productivity	1
as a basis for discussion based on pre-defined KPIs	5
for a clarification of responsibilites, functions, roles	1
for transparency about decision making	2
to check feasibility of KPI generation	1
1.5 Contribution to improve customer-orientation	0
utile to improve customer-orientation	1
for structured discussions	1
for dialogue/collaboration with customers	2
for service-orientation	1
for transparency of decision making / reasoning	2
partially utile to improve customer-orientation	1
if a trained person moderates	1
not utile to improve customer orientation	0
some terminologies are not clear for certain stakeholders	3
1.6 Contribution to Internal/external communication	0
utile for internal/external communication	2
to demonstrate development / trends	3
to foster transparency	1
to enable fact-based discussions instead of emotion-based	3
for goal oriented instead of error-centered discussions	1
to get people at one table	1
1.7 Contribution to knowledge management	0
utile for knowledge management	0
to have tangibility/transparency about consequences/actions	2
to involve staff	1
to proceed step by step	2
for a structured procedure	2
partially utile for knowledge management	0
if documentation is well done	2
as a beginning point	2
1.8 Contribution to cost reduction in processes	0
utile to reduce cost in processes	2

by accelerating processes	1
transparency = awareness/synergies = more efficiency	12
because people are forced to think about processes	1
directly or indirectly	1
possibly utile to reduce cost in processes	1
if the right questions are asked	1
partially utile to reduce cost in processes	0
more the KPIs than the model	1
not really utile to reduce cost in processes	1
more effort for handling = more cost	1
no estimation possible	1
1.9 Greatest benefits of model application	0
application alignment	1
stakeholder specific procedure	4
fact-based decision making instead of emotion-based	1
objective instead of subjective decision making	1
help to reach decision making by specialists	1
to reach transparency for good decision making	1
to get an overview on parameters and KPI compositions	3
possibility for stakeholder involvement	1
possibility for adjustments	1
consistent/structured/complete approach	4
2.1 Need for strategic re-design for model application	0
no need for strategic re-design	2
little need for strategic re-design	2
ask about the needs and requirements	1
medium need for strategic re-design	1
no estimation possible	1
depending on the specific context	1
start and then decide	1
2.2 Need for organisational re-design for model application	0
no need for organisational re-design	7
moderate need for organisational re-design	1
organisational change will happen after model application	2
2.3 Need for training for model application	0
little need for training	0
existing documentation well done	1
only a few people to be trained	2
getting familiar, then daily business	1
little need for controlling	1
little need for ICT	5
medium need for training	0
for technically oriented people	2
overall	1
high need for training	0
for further stakeholders	1
no estimation possible	2

2.4 Need for model adaptation	0
no need for model adaptation	2
low need for model adaptation	1
adding to introduction of new employees	1
moderate need for model adaptation	0
precision of model	1
extension of model	1
high need for adaptation	0
for strategic KPI pre-step	1
no estimation possible	2
would have to be assessed after a while	2
2.5 Need for internal/external model maintenance effort	0
low effort for internal/external model maintenance	2
moderate effort for internal/external model maintenance	2
sometimes more, sometimes less	2
because of fluctuation	1
should be dealt with regularly/monthly	7
no estimation possible	2
2.6 Effort-benefit relationship when appl. model	0
1. effort > benefit; 2. benefit > effort	3
effort clearly smaller than benefit	7
no estimation possible/difficult to say	3
2.7 Influence of model development context (PhD thesis)	0
no influence	8
positive influence	8
no estimation possible	1
2.8. Other model application possibilities	1
particular application on a tactical level	1
to introduce more qualitative KPIs	1
as an iterative approach	0
independent, systematic, structured, transparent procedure	3
to enforce a standardised procedure	1
as a checklist / to include all relevant aspects	2
2.9 Other aspects about the model	0
positive comments	0
good to initiate discussions and collaborative learning	2
model with pragmatic approach	3
model with no unnecessary frills	3
practical orientation / manageable model	1
challenges	0
a method is only good with a good consultant/application	2
internal consultants/moderators should be implemented	4
challenge to combine methodology + business knowl.	1
consider adding to the model	0
introduction of a glossary	1
pre-step with strategic KPI setup should be added	1

Appendix 26 – Material Processing in the Second Iteration of the “Evaluating” Phase

	Yes, particularly	**Maybe if**	**No because**
Model supports decision-making about KPI implementation	Stakeholder-management-related: - for the assessment of the stakeholders and their context - for discussions about the right KPIs - for the involvement of the stakeholders in the process - for the identification of stakeholders with chosen KPIs	Organisation-related: - organisational culture allows true application with all consequences - the overall goal/strategic mission is clear	KPI-related: - it doesn't help to define the correct/crucial/really necessary KPIs
Model supports decision-making about KPI reporting	Stakeholder-management-related: - for (iterative) discussions of reporting form - for the awareness of different stakeholders + their reporting needs	Organisation-related: - organisational culture allows true application with all consequences Reporting-related - suggestion about best presentation were	
Model supports decision-making about application alignment	Application-handling related: - to reach harmonisation - to rank applications - to handle interfaces - to know details about parameters Stakeholder-management-related: - to ensure common understanding - to talk about functionalities not products Process-related: - for having a structured process - for proactive / transparent planning		
Model supports decision-making in further contexts	Stakeholder-management-related: - for having a basis for discussion based on pre-defined KPIs - for the clarification of responsibilities, functions, roles - providing transparency about decision making - for the definition staff productivity Application-handling-related: - for determining penetration rate - for determining degree of standardisation of applications/solutions - for checking the feasibility of KPI generation		

	Yes, particularly	Maybe if	No because
Model contributes to improve customer-orientation	- for structured discussions - for the dialogue/collaboration with customers - for service-orientation - for offering transparency of decision making / reasoning	- a trained person moderates	- some terminologies are not clear for certain stakeholders
Model contributes to internal/external communication	- for demonstrating developments / trends - to foster transparency - to enable fact-based discussions instead of emotion-based / goal oriented instead of error-centred discussions - to get people at one table		
Model contributes to knowledge management	- for having tangibility/transparency about consequences/actions - for involvement of staff - for proceeding step by step - to have a a structured procedure	- documentation is well done - if it's seen as a beginning point	
Model contributes to cost reduction in processes	- because of more transparency, leading to more awareness in general and for synergies leads to more efficiency - by accelerating processes - because people are forced to think about processes - because it will happen directly or indirectly	- the right questions are asked more the KPIs than the model	- more effort for handling more reports means rather more cost

Greatest benefit of the model application	Stakeholder-management-related: - the allowance for stakeholder specific procedure - the basis for fact-based decision making instead of emotion-based (objective instead of subjective decision making, help to reach decision making by specialists) - the possibility for stakeholder involvement Application-handling-related: - for application alignment - to reach transparency for good decision making KPI-handling-related: - to get an overview on parameters and KPI compositions Process-related: - to have a consistent/structured/complete approach Model-related: - the inherent possibility for adjustments

	None because	Little/low need	Medium/moderate	High	Note
If the model were to be applied, how high is the need for strategic re-design be estimated	no need	- because needs and requirements have to be assessed	- generally speaking		- depending on the specific context - start and then decide
If the model were to be applied, how high is the need for organisational re-design be estimated	no need		- generally speaking		- organisational change will happen after model application
If the model were to be applied, how high is the need for training estimated		- because only specific/few positions have to be trained - for controlling and ICT stakeholders due to existing understanding - existing documentation is well done - because it's only necessary to familiar with it, then it becomes daily business	- for technically oriented people - generally speaking	- for further stakeholders due to missing understanding	
If the model were to be applied, how high is the need for model adaptation estimated	no need	- e. g. adding to introduction of new employees	- e.g. specification of the model - e. g. extension of the model	- for aligning and introducing strategic KPI alignment pre-step	
If the model were to be applied, how high is the internal/external effort for the model maintenance estimated		- generally speaking	- because it should be dealt with regularly/monthly - because sometimes more, sometimes less effort necessary - due to fluctuation		

	Benefit bigger than effort	Effort bigger than benefit	Note
If the model were to be applied, how is the effort-benefit relationship estimated	- clearly so - after a while	- most likely in the beginning (initial effort)	- difficult to estimate

Influence of model development context (PhD thesis vs. consulting)	No or positive influence

What would be other model application possibilities	- to have an independent, systematic, structured, transparent procedure - to enforce a standardised procedure - having a checklist / to include all relevant aspects - having an iterative approach - for particular application on a tactical level - to introduce more qualitative KPIs

	Positive comments	Challenges	Consider adding to the model
Other mentioned aspects about the model	- good to initiate discussions and collaborative learning - model with pragmatic approach - model with no unnecessary frills - practical orientation / manageable model	- a method is only good with a good consultant/application -> internal consultants/moderators should be implemented -> challenge to find the combination of methodology + business knowledge	- introduction of a glossary - pre-step with strategic KPI setup should be added