

Model-Driven Process Design

Aligning Value Networks, Enterprise Goals, Services and IT Systems

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to Kayla, Madison and Martin

Abstract

The purpose of business-IT alignment is to optimise the relation between business and IT in order to maximise the business value of IT. Successful business-IT alignment can be enabled by business processes and e-processes functioning as adaptive mediators between business and IT systems. Business processes are the ways actors work in enterprises and collaborate in value networks, while e-processes support a flexible flow of information between IT systems and business processes.

The overall goal of this thesis is to propose methods for business process and e-process design and evaluation for achieving alignment between enterprise goals and IT systems. The methods are based on model-driven approaches, using enterprise and software models. More precisely, the proposed methods can be used for designing models of business processes supporting the fulfilment of enterprise goals in the setting of a value network; for designing models of generic and reusable business processes that support the fulfilment of enterprise goals; for designing models of e-processes that support a flexible alignment of IT systems with business processes; and for evaluating the extent to which business processes are aligned with enterprise goals and IT systems.

The result of the thesis can be used to support business and system designers with practical knowledge on how to align business and IT systems in order to create efficient, high-quality, flexible and innovative organisations.

The research presented in this thesis has been carried out following the design science paradigm. This paradigm is characterised by the creation of new and innovative artefacts for solving general problems, and the evaluation of their benefits and drawbacks.

Keywords

business process design, e-process design, model-driven methods, enterprise modelling, business modelling, enterprise goals, services, value networks, business-IT alignment, design science

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Part II – Included Papers

1 Introduction

This chapter presents the background of the thesis, addressed research questions and goals.

1.1 Background

This thesis is about designing business processes and e-processes that support the alignment between an organisation's enterprise goals and IT systems. Such business-IT alignment can create an efficient, high-quality, flexible and innovative organisation - key characteristics to be successful in a competitive and swiftly changing environment (Pralhad and Krishnan, 2008). Therefore, the thesis can be seen as a contribution to the business-IT alignment research area. Furthermore, the solutions for achieving business-IT alignment presented in the thesis are based on model-driven methods, using enterprise and system models. Therefore, the thesis can also be seen as a contribution to the research areas of model-driven development and enterprise modelling.

The area of business-IT alignment can be defined as an area focusing on solutions that optimise the relation between business and IT in order to maximise the business value of IT. Such an alignment enables a more efficient way of working in an organisation since IT systems can support information storage and retrieval, decision making and the automation of information flow. This is also the traditional role of IT, i.e. the role of supporting business processes in order to make them more productive in an organisation. Business-IT alignment can also support organisations in more strategic ways, such as producing new or better products and services, supporting new relations with customers and vendors, and facilitating adaption to changed customer demands and emerging technologies. This is sometimes named "strategic alignment" (Henderson and Venkatraman, 1993). Instead of only focusing on the internal arrangement of business processes, an organisation also needs to consider business opportunities and manage changes in the external environment, including new and emerging IT capabilities (Druker 1988, Orlikowski, 2000, Orlikowski and Barley, 2001).

In order to manage a swiftly changing external environment, organisations demand new ways of conducting business. Organisations need to collaborate with vendors and business partners in order to deliver goods and services to the

mass market, but also to create tailored-made solutions for, and together with, individual customers (Prahalad & Krishnan, 2008). The role of organisations will be to continuously reconfigure the value networks of customers, vendors and other business partners in order to maximise business value. In such an environment, business services will increase in importance on behalf of products, which will become more and more embedded in business services. A customer buying a business service, compared with buying a product, does not need to take on typical ownership responsibilities, like infrastructure management, integration and maintenance. Instead, the customer can focus on how to make use of the service with a minimal burden on his/her own resources.

The thesis focuses on the design of business processes and e-processes in order to achieve business–IT alignment. Business processes are the ways actors work in enterprises and collaborate in value networks, while e-processes support a flexible flow of information between IT systems and business processes.

The designed business processes need to fulfil the goals of the enterprise, support the value networks and business services as well as make use of existing and emerging IT systems. Therefore, business processes can be seen as an adaptive mediator between enterprise goals, value networks, business services and the IT system (Hoque, 2002). That is, changes in goals, value networks, business services and the introduction of a new emerging IT system will be managed by adapting the existing business processes to the changed conditions.

The alignment of business processes and IT can be supported by a new kind of process, called an e-process or software process (Henkel, 2008; Perjons et al, 2005). E-processes describe the information flow between an organisation's different IT systems, and between the IT systems and the users. The models of e-processes can be executed in IT systems such as the Business Process Management System (BPMS) and Enterprise Services Bus (ESB), thereby automating the information flow. E-processes can easily be related and adapted to the business processes. Therefore, the use of e-processes will increase the flexibility of an organisation. If the information flow between IT systems needs to change in order to support changed business processes, this can be achieved by adapting the e-processes executed in BPMS or ESB, instead of making large changes to the IT systems. Furthermore, e-processes can also increase the innovativeness of an organisation. The creation of new innovative business services can be supported by bottom-up analysis of the existing IT systems' functionality and information, and by combining functionality and information using e-processes.

The alignment of business processes and IT can further be supported by means of e-services (Papazoglou and Yang, 2002; Piccinelli et al, 2002). E-services are layered above the IT systems, providing IT systems functionality

to business processes and e-processes. Changes in the business processes and/or e-processes can be managed by recombining existing e-services or by making use of e-services provided by external vendors. Therefore, when the business is requiring changes there is no need to carry out changes in the existing IT systems. Such changes in the IT systems may require system integration tasks, which is usually costly and time-consuming.

Designing successful business processes and e-processes is a complex and difficult task since the value network, enterprise goals, business services, e-processes, e-services and IT systems need to be aligned in order to create an efficient, high-quality, flexible and innovative organisation, see Figure 1. Therefore, there is a need for methods supporting the design of business processes and e-processes, as well as supporting the evaluation of the designed processes and their alignment with enterprise goals and IT systems.

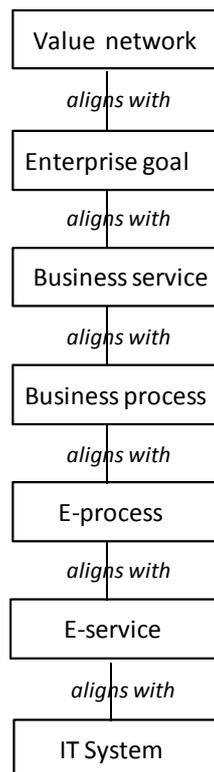


Figure 1. Value network, enterprise goals, business services, e-processes, e-services and IT systems need to be aligned in order to create an efficient, high-quality, flexible and innovative organisation.

1.2 Research Questions

The overall problem that this thesis addresses is the design and evaluation of business processes and e-processes that successfully use IT to support the fulfilment of enterprise goals. More precisely, the research questions addressed are:

- How to design business processes that support enterprise goals in a specific value network configuration of customers and vendors?
- How to design reusable business processes that support enterprise goals, i.e. how to design business processes that can be reused in different organisations?
- How to design e-processes that support the integration of IT systems with business processes?
- How to determine how well a business process is aligned with enterprise goals and IT-systems?

1.3 The Goals of the Thesis

The overall goal of this thesis is to propose methods for business process and e-process design and evaluation for achieving alignment between enterprise goals and IT systems. The methods are based on model-driven approaches, using enterprise and software models. More precisely, the goal of the thesis is to propose methods for:

- designing models of business processes that support the fulfilment of enterprise goals in the setting of a value network (sub-goal 1)
- designing models of generic and reusable business processes that support the fulfilment of enterprise goals (sub-goal 2)
- designing models of e-processes that support the alignment of IT systems with business processes (sub-goal 3)
- evaluating the extent to which business processes are aligned with enterprise goals and IT systems (sub-goal 4)

The purpose of the thesis is to support business and system designers with practical knowledge of how to align the business and IT system in order to create an efficient, high-quality, flexible and innovative organisation.

2 Theoretical Grounding

This chapter describes the theoretical grounding for the methods presented in the papers. Theoretical grounding means clarifying the relations between theories and concepts used in the actual research and theories and concepts used in external theoretical frameworks, accepted or discussed by the research community, see discussion in Goldkuhl (2004). The aim of theoretical grounding is to justify the actual research theoretically. First, the related research of importance to the methods is presented. Second, concepts from the related research are made explicit and related to each other in the form of a conceptual framework. This conceptual framework of the thesis will present the basic concepts used by the methods, as well as support an understanding of the relations between the methods.

2.1 Related Research

The research on business-IT alignment is vast and has its origin in the late 1970's, see, for example, McLean and Sonden (1977). Originally, business-IT alignment was focused on aligning business and IT plans in order to increase the productivity in business by using IT effectively (Chan and Reich, 2007). Today, business-IT alignment research is more focused on using IT as an enabler of new business opportunities. Such business-IT alignment research is sometimes named "strategic alignment" (Henderson and Venkatraman, 1993).

The business-IT alignment research has mainly been carried out in the discipline of management information systems (MIS) (Singh & Woo, 2009; Chan and Reich, 2007). However, the areas of enterprise and system modelling provide a large number of methods for achieving alignment between business and IT.

2.1.1 Business–IT Alignment Research in the MIS discipline

Business–IT alignment research in the MIS discipline seeks to develop and verify theoretical models that describe, explain or predict human or organisational behaviour regarding alignment. The research aims to identify factors that influence business–IT alignment, investigate business and IT

executives' views and awareness of business–IT alignment, assess the level of business–IT alignment in organisations using models and measures, and identify the organisational benefits of business–IT alignment. For an overview of business–IT alignment research in the MIS discipline, see Chan and Reich (2007).

The results from the business-IT alignment research in the MIS research discipline have shown that organisations that successfully align their business strategy with their IT strategy increase their organizational performance (Chan et al, 1997; Irani, 2002; Kearns & Lederer, 2003; de Leede et al, 2002). According to Chan et al (2006), evidence has also shown that alignment leads to a more focused and strategic use of IT, which, in turn, leads to increased performance. Furthermore, business and IT executives have for a long time been aware of the importance of business-IT alignment, and they have considered it as a top priority in their business for over two decades (Luftman et al, 2005). However, there have been researchers questioning the benefit of alignment. Vitale et al (1986) claim that a non-flexible alignment can prevent necessary change in the business, and Chan and Huff (1993) mean that IT should also challenge the business, not only follow it. Research has also shown that business strategy can be unknown among managers; can be difficult to understand and adapt: or may not exist at all in an organisation (Chan and Reich, 2007).

MIS research has identified a number of factors (i.e. antecedents) that support alignment. Examples of such factors are: continuous communication between business and IT executives (Reich & Benbasat, 2000), the existence of a strategic business plan (Lederer & Mendelow, 1989; Vitale et al, 1986; Reich & Benbasat, 2000), connections between IT and business planning processes (Reich & Benbasat, 2000) and credibility of the IT group due to prior IT success (Reich & Benbasat, 2000). However, according to contingency perspectives, factors will have different outcomes in different contexts or environments, such as the type of industry, size of the organisation, type of business strategy, the emphasis on innovation, and the degree of environmental turbulence. Other researchers have claimed that alignment is an ongoing process and it is not enough to simply understand the factors involved in alignment; the relations between the factors are at least as important (Beats, 1996).

Strategic Alignment Model (SAM)

The most widely cited theoretical model, and perhaps the most influential one, is the Strategic Alignment Model (SAM), developed by Henderson and Venkatraman (1993). Several researchers have built on and extended the SAM model (e.g., Avison et al, 2004; Goedvolk et al, 1997; Luftman et al, 1993). The aim of SAM is to better understand the full potential of IT, i.e. to

understand how IT can both support and shape new business strategy initiatives.

SAM consists of four domains of strategic choice for an organisation (see Figure 2):

- *Business strategy*, for strategically positioning the organisation in the external environment (i.e. product-market offerings, make vs. buy decisions, partnerships/alliance decisions)
- *Business infrastructure and processes*, for managing the work of the organisation
- *IT strategy*, for strategically positioning the organisation in the external IT marketplace, including the future need for emerging IT solutions
- *IT infrastructure and processes*, for managing the IT support of the organisation

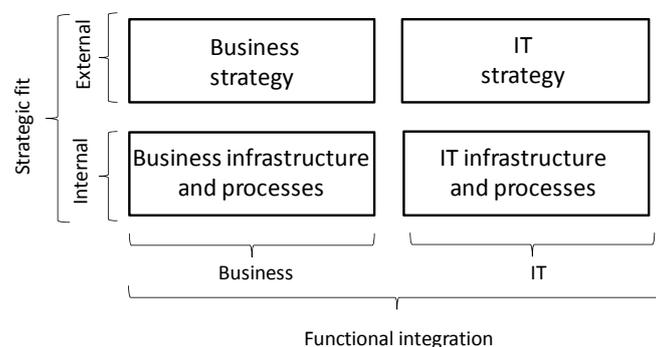


Figure 2. A simplified version of SAM, based on (Henderson and Venkatraman, 1993).

According to Henderson and Venkatraman (1993), organisations need to consider a *strategic fit* between the business position of the organisation in the external competitive product-market arena, and the internal design of the business infrastructure, as well as a *strategic fit* between the external IT marketplace and the internal choice of IT infrastructure. Henderson and Venkatraman (1993) also claim that organisations need to consider the functional integration between business strategies and IT strategies as well as between business and IT infrastructures.

As discussed above, SAM supports an organisation in analysing the potential role of IT. For example, emergent IT solutions in the IT marketplace can be an opportunity for an organisation to change its business strategy and business infrastructure. Therefore, an organisation needs to consider IT-driven

perspectives as well as business-driven perspectives. However, the most dominant alignment perspective in research and in practice is business-driven, or more precisely, the perspective when a business strategy will be the driver of both the business infrastructure and the IT infrastructure design. According to Henderson and Venkatraman (1993), enterprise modelling is one possible methodology for making this business-driven perspective operational.

In the papers of this thesis, the main business–IT alignment perspective is that business strategy is the driver for both business and IT infrastructure design. However, by the introduction of e-processes, an IT-driven perspective can also be supported. E-processes can be used to identify and provide new IT functionality and information from existing IT systems. This IT functionality and information can then be the basis for designing a new business strategy and/or changing the way of working in the business infrastructure.

2.2.2 Business–IT Alignment Research in Enterprise Modelling

Several methods in enterprise and system modelling aim to analyse and design solutions that support alignment between business and IT. In this section, some of these methods are presented and related to the methods presented in this thesis.

Enterprise modelling, sometime called business modelling, is the process of using models to represent an enterprise’s business processes, resources, people, information, constraints, and organisational structure. The enterprise’s context could also be represented as a model, for example, a model of the value network in which the enterprise exchange resources with customers and vendors.

Enterprise modelling can be used for representing the enterprise “as-is”, that is, to describe a present state of the enterprise. The “as-is” descriptions can be used for analysis of the enterprise in order to identify problems and possible solutions. Enterprise modelling can also be used for representing the enterprise “to-be”, that is, to describe a future state of the enterprise. Such descriptions can be used for analysis of one future state, or for comparing several future options for the enterprise. Most of the methods presented in this thesis aim at designing “to-be” models.

Enterprise models are usually shown as graphical diagrams, which makes them easy to understand and manipulate for any stakeholder, thereby facilitating shared understanding. At the same time, enterprise models are so precise that they can be used as a basis for designing IT systems and e-services. Therefore, much research based on enterprise modelling is used for requirements engineering, that is, the process in which functional and non-functional requirements on IT-systems are elicited, specified and validated (Nilsson et al, 1999).

System models are descriptions of IT systems. A system model could represent the processes carried out in an IT system (for example, a set of method executions); the information used by the IT system; and the static structure (i.e. architecture) of the IT system. System models can also be “as-is” or “to-be” descriptions. Systems models “as-is” are important for managing maintenance of a system, while system models “to-be” can be used as a specification for the system to be designed.

Different types of enterprise and system models can also be combined. For example, business process and business information models can be combined in order to describe which information is received and provided in each activity of the business processes. The models combined can also be on different abstraction levels. For example, a strategic model, such as a goal model; an operational model, such as a business process model; and a system model can be combined. Thereby, a business-IT alignment model “is-as” can be constructed. This model can then be used for analysing the current state of alignment between business and IT. However, business-IT alignment models “to-be” can also be constructed. Such a “to-be” models can be used for analysing different alignment options, see discussion in Hoque (2002), and also Nilsson (1999b).

Enterprise and system models on one abstraction level could drive the design of models on other abstraction levels. This means that a strategic model, such as a goal model, can be used as a base for identifying operational models, such as business process models. A business process model can, in turn, be the base for identifying system models. In order to carry out such a model-driven approach, the transformations from one abstraction level to another level need to be specified. The transformations include rules or guidelines for how model elements in one model are used for creating model elements in another model. In enterprise modelling, the transformations are usually carried out manually by a business analyst. In system modelling, there exist a number of tools for performing the transformations automatically - from abstract system models, usually called platform independent models, to more technical models, usually called platform dependent models (Kleppe, 2004). It is also possible to carry out transformation from technical or detailed models to more abstract, in order to achieve overview and, thereby, identify new and more effective solutions.

Process Models

In this thesis, the focus is on designing business processes and e-processes, since they can work as adaptive mediators between strategic models and system models. Business process models are a type of enterprise models describing how actors work in enterprises and collaborate in value networks. According to Hruby (2006), there exist two types of business processes, exchange business processes and conversion business processes. In exchange

business processes, actors in a value network transfer resources between each other. For example, a customer is buying a car from a car dealer, and the resources transferred between the actors will be a car and money. In a conversion process, an actor is using or consuming resources to produce other resources (which then can be used in an exchange business process for exchanging resources with the customers). For example, a company can consume spare parts and use machines to produce goods (which can be sold to a customer). According to Hruby, carrying out exchange and conversion processes are the two ways an organisation can increase its values. In Paper 1, exchange and conversion processes are discussed as well as the concept of resource. In the paper, a resource is defined as an object that is viewed as valuable for an actor. The paper specifies two types of resources: economic resources, which can be transferred between actors, such as goods, services, money and information, and internal resources, which cannot be transferred, such as health state and honour. A transfer of an economic resource (e.g. a health care treatment) can be converted into an internal resource (e.g. health state). The concepts of economic and internal resource are used for the design of innovative actions, which is the goal of Paper 1.

E-processes are a type of system models describing the information flow between an organisation's different IT systems, and between the IT systems and the business processes. E-processes can also span the borders of an organisation and describe the information flow between several organisations, which need to exchange information between each other. The e-processes presented in this thesis are executable models, which means that they can be executed in IT systems, such as the Business Process Management System (BPMS) and Enterprise Services Bus (ESB). Thereby, the executed e-processes will automate the information flow. In this thesis, Paper 3 and 4 discuss e-processes and their benefits, such as managing flexible changes in both the business processes and the IT architecture. E-processes provide a flexible integration of IT systems, and can also be easily related and adapted to business processes.

For designing a process model, a formal process modelling technique can be chosen. Today, there exists a number of more or less formal process modelling techniques. Bider and Perjons (2009) have categorised them in the following way:

1. *Input/output flow*. The process modelling techniques in this category focus on resources that are being used or consumed, produced or changed, by the activities. This flow can be represented as a diagram (graph), where activities serve as nodes. The arrows connect the activities in accordance to how the results of one activity are being used by subsequent activities. Such a diagram does not represent the order of activities directly, rather it reflects the causal order, i.e. how the results of one activity are used by another activity. However, the

causality establishes a partial order between activities indirectly, as the resources needed for one activity must be produced before they can be used. The most common approach to represent this kind of flow is IDEF0 (FIPS, 1993). In this thesis, IDEF0 is not used in any of the paper presented, but the technique is used in Section 3.1 and 3.2 for describing the research processes carried out.

2. *Workflow*. The process modelling techniques in this category focus on the order of activities in time. This flow can be represented as a diagram. Usually, nodes of the diagram represent activities, while arrows represent the flow, i.e. the order of the activities. Typical notations for representing workflows are IDEF3 process flow diagrams (Mayer et al., 1995), Activity Diagrams of UML, see OMG (2010a), Business Process Model Notation (BPMN), see OMG, (2011). Petri Nets (Aalst, 1999, Deiters&Gruhn, 1998), and Yet Another Workflow Language (YAWL), see Aalst and Hofstede (2006). In this thesis, BPMN, is used in Paper 7 to analyse a business process. Paper 7 is also using an existing framework for process description and analysis (Jablonski, 1995). The framework provide an analysis of a business process based on which activities exists in the process, the flow of activities, the flow of information, and responsible roles for carrying out the activities.
3. *Agent-related view*. The process modelling techniques in this category focus on the order in which agents get and perform their part of work. The agent-related modelling techniques specify the resources, usually information or messages, sent between the agents, as well as activities carried out by them. Some agent-related techniques also use the notion of state. The typical notation to represent this kind of flow is Role-Activity Diagrams (RAD), (Huckvale and Ould, 1998). Two other examples of process modelling techniques having a agent-related view are Specification and Description Language, (SDL) see ITU-T (2002) and Business Model Language (BML), see Johannesson and Perjons (2001). Both these two techniques can be used for modelling e-processes. The two techniques focus on the information flow, or more specifically, how messages are sent between processes and agents. Therefore, the two techniques can also be categorised as communication oriented process techniques or languages. In this thesis, BML is described and applied in Paper 4 and 5.
4. *State flow*. The process modelling techniques in this category focus on the order of states in a process. A state is a change in the part of the real world that embraces a given process instance. The state change can be caused by an activity and/or event. In IDEF3 (Mayer et al., 1995), the state flow is used as a complementary view to the activity flow. In

a UML State-Machine Diagram (OMG, 2010a), the state flow is the main focus, although State-Machine Diagrams are mainly used for modelling the states of software objects and not for modelling business processes. Another exploitation of the state flow view is state-flow technique (Bider, 2002). In this thesis, state-flow technique is used in Paper 2 and 3. The state-flow technique is especially useful to model loosely-structured business processes, i.e. processes where it is difficult to establish an order of activities. The state flow-technique is one possible approach for designing more flexible business processes since no pre-defined activity flow needs to be designed. Another approach for designing flexible business processes can be found in Heinel et al (1999) and Aalst and Basten (2002), where abstraction of activities are used for not specifying a too detailed way of working.

In research and practice, there has been a vast interest in business process patterns. A process pattern is an abstract process design solution for recurrent problems. A formal approach for defining patterns for business processes is presented in Aalst and Hofstede (2003). This approach define various ways of ordering activities in workflow, e.g. task sequencing, split parallelism, join synchronisation, and iteration. Another methodology for defining and exploiting business process patterns is presented in Malone et al (1999). A large collection of both general and specialised business process patterns has been constructed for process improvement purposes. Organisations can use the constructed patterns for designing or improving their own processes. For example, patterns of sales or a production process can be used, as well as different types of specialisations of these processes. Both types of patterns presented above are based on a workflow view of business processes.

In this thesis, two other types of process patterns are designed. In Paper 2, a definition of a goal-oriented business process pattern is presented based on the state-flow technique. The pattern provides a controlled abstraction from many details, without losing the essential nature of a business process, i.e. the goal of the process. In Paper 4, patterns for e-processes are presented based on BML, which, for example, can be used for releasing resources automatically, such as non confirmed reservations in IT systems. The theoretical base for the constructed patterns is speech acts theory (Searl, 1969). A speech act is a linguistic act by which an actor influences social and/or institutional relationships. Examples of speech acts are assertive, i.e. an actor is informing another actor about a state of affairs, and commissive, i.e. an actor is promising another actor to perform an action in the future. Many researchers have used speech acts to analyse business processes and communication between actors, as well as to support the design of IT systems, see, for example, Winograd and Flores (1986) Lind and Goldkuhl (1997), and Dietz (1994).

Goal Models

Goal models are another type of enterprise models used in this thesis. Goal models have been used in requirements engineering to understand a problem domain and to identify the interests of different stakeholders. The research area is called Goal-Oriented Requirements Engineering (GORE), summarised in Lamsweerde (2004). Goals models can also be used for representing business strategies as they can govern the enterprise towards concrete actions. High-level goals can be refined in order to identify more actionable and measurable goals. Many researchers have used enterprise goals as a basis to drive the process design, see for example Bider (2002), Soffer and Wand (2005), Nurcan et al (2005), and Edirisuriya and Zdrakovic (2008).

One of the most widely known techniques for goal modelling is i^* (Yu, 1995; Yu et al, 1995), which provides constructs for modelling goals, tasks, resources, and dependencies between actors. While i^* holds a strong position in the academic community, there are also goal modelling languages with a more practical orientation. One of these languages is the Business Motivation Model (BMM), see (OMG, 2010b; Bridgeland and Zahavi, 2009). BMM is used in Paper 1.

In this thesis, goals have been used to drive the design of processes in Paper 1, Paper 2, and Paper 3. In Paper 1, a goal model was applied on each resource transfers in a value network in order to identify efficient, high quality, secure and innovative actions to implement among the actors in the network. In Paper 2 and 3, goal-oriented business processes were designed based on the state-flow technique.

Value Models

Value models, also called business models, are a third a type of enterprise models that are used in the thesis. A value model is a representation of a network of cooperating actors that together create value through resource transfers and conversions. Value models have their origin in commercial contexts, where they have been used for analysing the economic viability of value networks and their participants.

A value model gives a high level view of the actions taking place in and between organisations by identifying actors, resources and the transfer of resources between the actors, i.e. a value model focuses on the what in business. They provide a compact view of the environment of an organisation by focusing on its value aspects and disregarding procedural aspects.

There exists a number of ontologies for value modelling/business modelling, such as REA (McCarthy, 1982), BMO (Osterwalder, 2004) and e3 value (Godijn, 2002). Resource-Event-Agent (REA) ontology was originally developed to manage double-entry bookkeeping in accounting information system (McCarthy, 1982). In Hruby (2006), REA has been extended for

designing more general business-oriented IT systems. e3 value is not only an ontology but also a modelling technique, see Gordijn and Tan (2005). In Gordijn (2003), e 3 value is used for requirements engineering.

Several researchers have used value models as a ground for designing process models, see for example Jayaweera (2004), Pijpers and Gordijn (2007), Andersson (2006). The resource transfers between the actors can, for example, be the basis for designing exchange processes. By adding constraints, such as the order of the resource transfers, a more detailed exchange processes can be transformed for the value model in a model-driven way.

In this thesis, value models are used in Paper 1 and Paper 6. In paper 1, the resources transfers between the actors in a value network are combined with goal models to drive the identification of efficient, high quality, secure and innovative actions. The identified actions can be implemented by actors in the network. In paper 6, the value models are used as a starting point for identifying KPIs for measuring service and process quality.

Business Services and e-services

The increasing interest in services has created a multitude of alternative views and definitions of the service concept. What constitutes a service is still a matter of debate, in industry as well as in various research communities.

One approach to structuring services is to divide them into business services and e-services. Several researchers have used business processes as a starting point for the identification of e-services (Terai et al.,2003; Piccinelli et al., 2002; Papazoglou and Yang, 2002).

In Henkel (2008), the relationship between business processes and e-services are investigated from both a top-down and bottom-up perspective. A bottom-up perspective means that the e-services can shape the business. However, this shaping of business processes can adversely affects the business process. For example, existing e-services can limit the number and types of customers that can be handled. From a top-down perspective, business processes affect the way e-services are designed. Combining the top-down and bottom up perspectives can yield e-services that support the business process, without an overly large investment in e-services and e-process implementation costs. Henkel (2008) also discuss the use of e-processes, similar to the ideas presented in Paper 5.

In Paper 7, a method is presented for identifying an e-service unintended negative impact on business processes. The method also suggests tentative solutions for better alignment between the e-services and the business processes. In Paper 6, a model-driven approach for identifying KPIs for measuring quality of health care business services and business processes. The approach is combining value models, goal models, service quality models, such as SERVQUAL (Parasuraman et al, 1988), and conceptual models.

2.2 Conceptual Framework Used in the Thesis

This section presents a conceptual framework (see Figure 3) being theoretically grounded in the related research presented in Section 2.1. The framework is the conceptual basis for the methods presented in this thesis. Furthermore, some concepts are used in all the methods, while others are used in only one or some of the methods. Therefore, the conceptual framework will also support the understanding of the relations between the presented methods in this thesis. Below, each of the concepts are defined, exemplified and related to other concepts. The concepts and their relations in Figure 3 are modelled using the UML Class diagram technique (OMG, 2010b). Note that an arrow with a hollow arrow head in Figure 3 shows a generalisation-specialisation relationship between concepts.

The concepts in the theoretical framework are:

Actor

Definition: a physical person, organisation or role

Examples: “Kayla Neufeldt”, “IKEA”, “CEO”, “customer”

Resource

Definition: an object being viewed as valuable for some actors.

Examples: “car”, “£ 200”, “gas”, “health care treatment service”

Goal

Definition: a desirable state for an actor

Examples: “the patient shall only need to wait 30 minutes for the result of the investigation”, “my salary shall be at least 30 000 SEK a month”

Enterprise goal

Definition: a goal specified for an organisation

Examples: “health-care treatments at our hospital shall have high quality”, “sale revenue in the company shall increase by 5 percent per year”

Service

Definition: a resource that embeds other resources and is provided by actor(s) to be consumed by another actor(s).

Examples: see business service and e-service

Business service

Definition: a service that fulfils enterprise goals

Examples: “renting a car service”, “dinner service”

Goods

Definition: a resource that is physical (tangible)

Examples: “car”, “real estate”

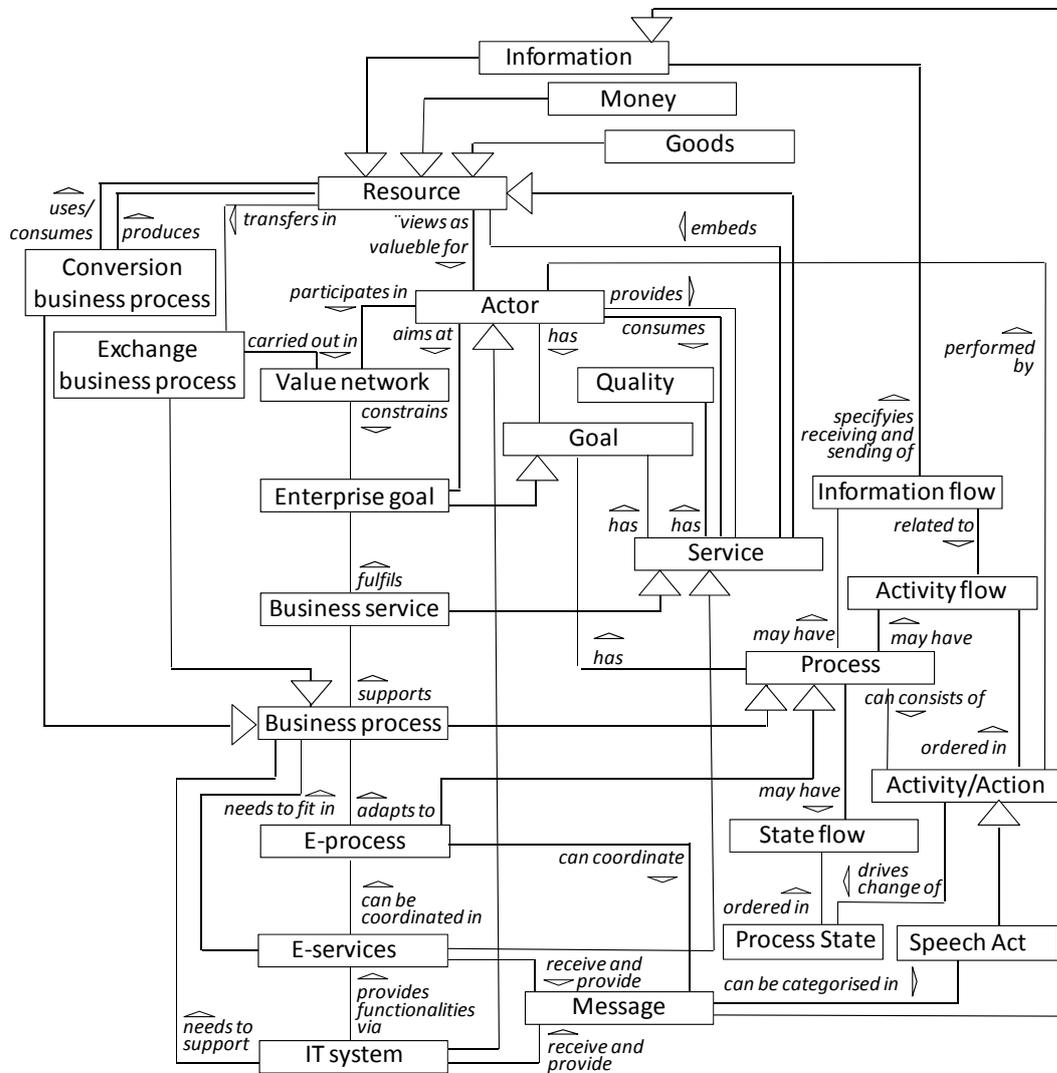


Figure 3. The conceptual framework describing concepts grounded in related research and used by the methods described in this thesis. (Note that an arrow with a hollow arrow head shows a generalization-specialisation relationship between the concepts.)

Money

Definition: a resource that is accepted as payment for goods, services and information

Examples: “25 000 SEK”, “£ 200”

Quality

Definition: a property of a service that satisfies a need of a customer

Examples: “prompt service delivery”, “well-dressed and neat appearance of employees”, “understandable explanation of the service”

Activity/action

Definition: something that is performed by an actor

Examples: “check an order”, “mount a mobile phone”

Activity flow

Definition: an ordered set of activities

Examples: “the activity *check a purchase order* shall be performed before the activity *accept a purchase order*”

Process

Definition: an ordered, or partially ordered, set of activities or states, which has goal(s)

Examples: see business process and e-process

Business process

Definition: a process that aims to reach enterprise goals

Examples: “sales process”, “production process”

E-process

Definition: a process that coordinates messages to and from IT systems in order to automate the information flow and can be executed in a BPMS for automating the message flow

Examples: “an electronically carried out management process for purchase orders”

Process state

Definition: a set of values of properties that describe how much has been carried out for an instance/case of the process

Examples: “the merchandise is shipped”, “a purchase order is received”

State flow

Definition: an ordered set of process states

Examples: “the state *purchase order is received* must be reached before the state *purchase ordered is accepted*”

Information

Definition: a resource that consists of data with some meaning

Examples: “invoice”, “notes from a meeting”

Message

Definition: a message is information that is sent from a source to a receiver

Examples: “invoice”, “purchase order”

Information flow

Definition: an ordered set of information received and provided by activities in a process

Examples: “a quote needs to be received before a purchase order can be sent”

Speech act

Definition: a linguistic act by which an actor influences social and/or institutional relationships

Examples: “commissive”, which is a promise, for example a promise to pay for a product

E-service

Definition: a service being carried out by one or several IT systems

Examples: “buy a book e-service” at Amazon

IT system

Definition: a computer system supporting information storage and retrieval, calculations, decision making and/or the automation of information flows

Examples: “ERP system” at Ericsson

Conversion business process

Definition: a business process using/consuming resources to produce other resources in order to increase value for an actor

Examples: “a car company uses spare parts to produce cars”

Exchange business process

Definition: a business process where actors are transferring resources in order to increase values for the actors

Examples: “a car dealer transfers a car to a customer and the customer transfers money to the car dealer”

Value network

Definition: a set of actors transferring resources in exchange business processes (and, thereby, increasing value for the actors)

Examples: “primary care units and hospitals are collaborating in order to provide healthcare services to patients. The patients (and tax payer) will provide the healthcare actors with money and the healthcare actors will provide the patients with services to gain better health states”

3 Empirical Grounding

This section describes the empirical grounding for the methods presented in the papers in this thesis. Empirical grounding means clarifying the relations between theories and concepts used in the actual research and the empirical findings. The aim of empirical grounding is to justify the actual research empirically, see discussion in Goldkuhl (2004). In order to achieve such a justification, a well-structured research process has to be designed and applied, including evaluation of the research results.

First in this section, the research paradigm of design science is described and discussed as well as how that paradigm could be transformed into a design science research process. Second, the actual research processes carried out in the papers are described. Third, the research projects, which constitute the empirical base for the research, are presented.

3.1 Design Science

Design science paradigm

The research presented in this thesis has been carried out following the design science paradigm. This paradigm is characterised by the creation of artefacts for understanding and addressing general (i.e. unsituated) problems in a business setting.

The created artefacts are of different kinds. March and Smiths (1995) have proposed a classification consisting of four types of artefact: constructs, models, methods, and instantiations. Constructs are concepts and notions that form the basis for languages that can be used for formulating problems and solutions. Models are representations of existing, or imagined, states of affairs that support understanding and navigating problem and solution spaces. Methods define systematic ways of carrying out activities and may range from algorithms and formal procedures to guidelines and rules of thumb. Instantiations are implemented prototypes or IT systems built using constructs, models and methods.

Important in design science is that the designed artefacts will create new realities when applied, e.g. an artefact may change the way actors interact and

work in a business setting. That is, design science research will develop artefacts creating new realities, and evaluate the benefits and drawbacks of the artefacts in these new realities – rather than explaining the existing realities. Hevner et al (2004) state that the design science paradigm “seeks to extend the boundaries of human and organisational capabilities by creating new and innovative artefacts”.

Hevner et al (2004) contrast design science with the behaviour science paradigm. Behavioural science has its origins in natural science and aims at creating knowledge in the form of models and theories that can be used for analysing, explaining and predicting both human and organisational behaviour. The goal of behavioural science in the context of information systems is truth in the sense that it aims at extending and improving our knowledge about existing human and organisational aspects of information systems, including their development, management and use. In contrast, the goal of design science is utility in the sense that it seeks to create innovations, including models and methods, for supporting the development, management and use of information systems. Design science originates from the engineering disciplines and the sciences of the artificial (Hevner et al, 2004).

Design science and behavioral science are distinct, but closely related, as the creation of artefacts in design science research is informed by knowledge of information systems produced in behavioural science. Likewise, behavioural science will study artefacts produced by design science and applied in the business setting. Thus, the two paradigms are interrelated in a complementary research cycle alternating between artefact innovation and knowledge creation.

As design science aims at creating useful artefacts, it needs to strike a balance between relevance and rigor. Relevance implies that the problem addressed is viewed as important by practitioners and in need of novel solutions. Furthermore, proposed solutions should be possible to apply in real business settings. However, the solution design and evaluation should also be rigorous, i.e. based on established knowledge foundations and research methods. Achieving both relevance and rigor is a difficult task, as many design science problems are situated in highly complex environments and the rate of technological change is ever increasing.

The design science paradigm has similarities to action research, as stated by Järvinen (2007). Action research aims to solve practical problems for a client (i.e. practitioner) and at the same time contribute to the research knowledge foundation. That is, action research has dual goals, one goal related to the client and one related to the research community, similar to the discussion in design science about the need to both solve business problems and contribute to the knowledge foundations of the research community (Hevner et al, 2004).

Although there are similarities between design science and action research, Iivary and Venable (2009) have identified a number of differences between them. First, design science is more a research orientation while action research

is a research method. Second, design science is mainly focused on unsituated problems while action research is focused on situated ones. Third, design science does not assume any specific client or collaboration between the client and the researchers. According to Rapoport (1970), the action research method requires a joint collaboration between clients and researchers in a mutually accepted framework. Fourth, design science is more varied in its paradigmatic assumptions, for example, design science includes both positivist and anti-positivist assumptions in its epistemology, while action research includes mainly anti-positivist assumptions.

In this thesis, we claim that design science research can include different research methods such as action research and case study in different phases, for example during the problem formulation, artefact design, and evaluation phases. Venable and Travis (1999) and Venable (2006) have argued for using methods such as action research for evaluation of outcome of design science research, although Iivary and Venable (2009) have argued that such a combination is not unproblematic because of the different paradigmatic assumptions.

A design science process

In order to provide practical guidance for researchers who will carry out research according to the design science paradigm, Peffers et al (2007) have developed a design science research process. The process consists of a set of sub-processes, see Figure 4.

The design science research process according to Peffers et al (2007) can, somewhat simplified, be described as follows: First, a business problem that motivates the research needs to be identified. Second, the objectives of the artefact need to be defined, which can be seen as a transformation of the problem into the requirement for the artefact. Examples of such requirements can be criteria for performance, usability, and aesthetics. The stated objectives will also specify in which way the artefact is different from other solutions. Third, the artefact needs to be designed and developed. Fourth, a demonstration of the developed artefact needs to be carried out. This means a description that shows how the artefact can solve one or several instances of the problem addressed. This is sometimes called “proof of concept”. Fifth, an evaluation needs to be performed to measure the fulfilment of the defined objectives of the artefact. Sixth, the result of the research needs to be communicated to the research community. The results of the evaluation and communication sub-processes can give input to new or refined objectives of the artefact and/or to a change in the design of the artefact (see the process iteration arrows in Figure 4).

According to Peffers et al (2007), a researcher could start in any of the four first sub-processes, see Figure 4. For example, an artefact could have been

designed and developed to solve one business problem but later on be identified for solving other problems. In such a case, the sub-process “Design and develop” precedes the first two sub-processes in Figure 4 in time. This means that the researcher needs to carry out the sub-processes “Identify problem and motivate” and “Define objectives of a solution” when the artefact has been designed and developed. Therefore, the order of the activities in the design science process presented by Peffers et al, (2007) could be interpreted as a description of how the research process needs be presented in order to make sense for the audience, rather than presenting in which order the activities were carried out during the actual research process.

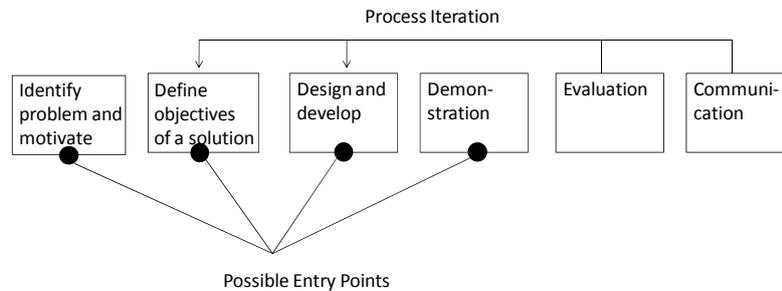


Figure 4. A design science research process (Peffers et al, 2007).

A template of a design science process (TDSRP)

In this section, a template of a design science research process (TDSRP) is presented. It is a modification of the design science research process presented by Peffer et al (2007). The TDSRP will support a structural description of research carried out, and describe how the research presented in this thesis was carried out, see the next section.

The TDSRP is described using a standard process description technique, called IDEF0 (FIPS, 1993). IDEF0 was chosen for this purpose because it is easy to understand and use, and the technique has an efficient decomposition feature, in which a process can be decomposed into several levels of details.

The IDEF0 technique describes a system (e.g. organisation, IT system) as a number of functions (e.g. processes, operations, activities), graphically represented as boxes (see Figure 5). Each function can be decomposed into sub-functions, which can be decomposed into further sub-functions and so on. Furthermore, a set of channels conveying data or objects are related to each function.

In this thesis, four types of channel from the IDEF0 technique are used: input, output, control and mechanism, graphically represented as arrows. Input arrows are associated with the left side of an IDEF0 box, output arrows with the right side, control arrows with the top side, and mechanism arrows with the

bottom side, see Figure 5. Inputs are transformed or consumed by the function to produce outputs. Controls (e.g. blueprints, rules, guidelines, methods, instruments) govern the function to produce correct outputs, while mechanisms are the means (e.g. resources, domain knowledge) being used to support the execution of the function.

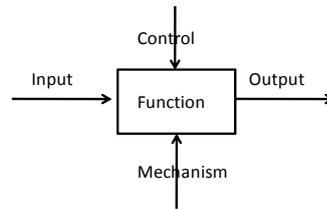


Figure 5. Basic concepts in the IDEF0 technique.

In the TDSRP, we use the four channels in the following meaning:

- *Input* (arrow from left) – describes which knowledge type is used as input to a function
- *Output* (arrow to right) – describes which knowledge type is used as output to a function
- *Control* (arrow from above) - describes which knowledge type is used as control to a function. Controls are research methods, data generation methods and data analysis methods
- *Mechanism* (arrow from below) – describes which knowledge type is used as mechanism to a function. Mechanism is the knowledge foundations such as theories, constructs, models and methods

The TDSRP consists of three levels of detail of the research process. The first level shows a generic research process (see Figure 6), which is decomposed into two main research processes: operational research process and governance research process (see Figure 7). The third level is a decomposition of the operational research process into six sub-processes (see Figure 8).

The first level of the TDSRP is an abstract description of the research process, showing all the research activities as one single process (see Figure 6). This generic research process (function) consumes an initial problem (input) and produces both an artefact (output) and artefact knowledge (output). The initial problem is a preliminary formulation of the research problem being addressed. This is often a practical business problem viewed as important by an organisation. The artefact is a construct, model, method or instantiation, and

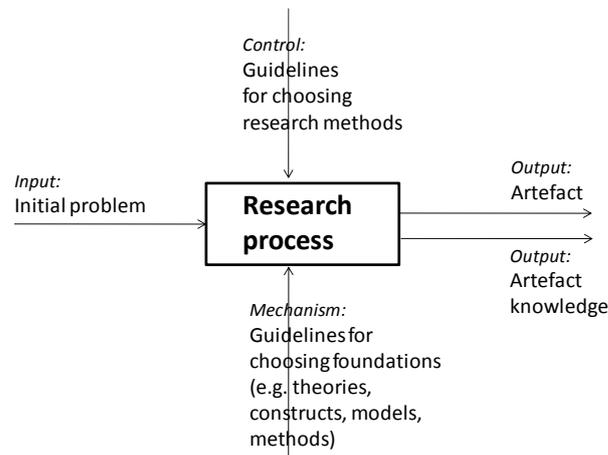


Figure 6. First level of the TDSRP

the artefact knowledge is the knowledge gathered about the artefact during all the carried out research activities. Furthermore, this generic level shows the research process governed by guidelines for choosing research methods (control), rather than chosen research methods. This means, that the choice of research methods is abstracted away and is not shown on this level, but will be visible on levels two and three. In the same way, it is the guidelines for choosing foundations (mechanisms), rather than the chosen foundations being shown. Foundations are theories, constructs, models, and methods used as the theoretical base for the research carried on at the operational level.

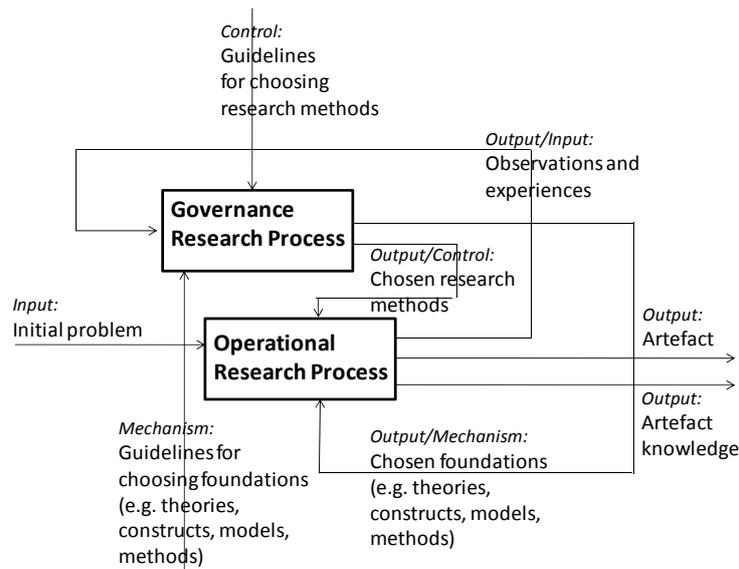


Figure 7. Second level of the TDSRP.

The second level of the TDSRP consists of two processes: the operational research process and the governance research process (see Figure 7). These two processes are a decomposition of the research process at the first level.

The operational research process consists of the day-to-day activities aiming at designing an artefact (output) and artefact knowledge (output) to solve an initial problem (input). The process is governed by the chosen research methods (controls), and uses knowledge foundations (mechanisms). The process also produces observations and experiences (output) from the used research methods and knowledge foundations, which is the main input to the governance research process.

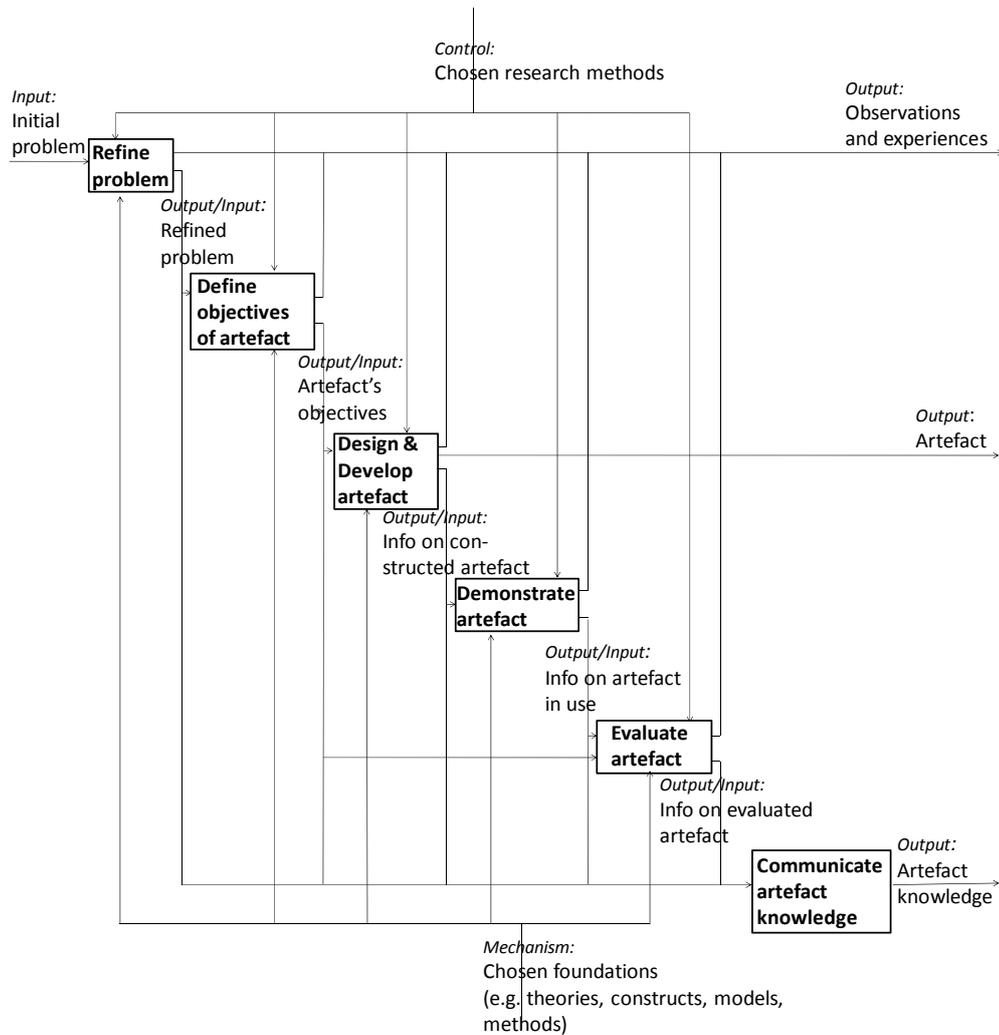


Figure 8. Third level of the TDSRP – the operational process.

In the governance research process (see Figure 7), actors reflect from time to time on the operational process in order to decide which research methods and foundations to use therein. In order to produce both an appropriate research method (output) and knowledge foundations to be used (output), observations and experiences (input) are needed from the operational research process

The third level decomposes the operational research process into six sub-processes, named: “refine problem”, “define objectives of a solution”, “design and develop artefact”, “demonstrate artefact”, “evaluate artefact”, and “communicate artefact knowledge”, see Figure 8.

The first sub-process, refine problem, elaborates the initial problem (input) in order to formulate an explicit and more precise problem, i.e. a refined problem (output). The initial problem should have explicit relations to an organisation’s business benefits, such as organisational efficiency, flexibility, innovation, and/or high quality of services and products. The refinement of the initial problem is performed mainly based on domain knowledge from the foundation (mechanism). A common research method (control) for governing this sub-process is the use of conceptual modelling. The refinement of the problem could also be carried out using an action research method (control).

The second sub-process, define objectives of a solution, specifies the desirable features of an artefact, i.e. the objectives of the solution (output), based on the refined problem (input). The objectives of the solution in the TDSRP specify the quality properties of the artefact, such as completeness, coherence and efficiency. The output from this step will guide the development of the artifact in step three of the method. Furthermore, the objectives of the solution will form the basis for the evaluation of step five.

The third sub-process, design and develop artefact, aims at constructing an artefact (output) as well as produce information on the constructed artefact (output) addressing the refined problem, and taking into account the artefact objectives (input). Designing an artefact includes determining its functionality, as well as its architecture.

The fourth sub-process, demonstrate artefact, aims at showing the use of the artefact in an illustrative or real-life case, thereby proving the feasibility of the artefact. The demonstration is based on information on the constructed artefact (input). The result of the demonstration is information on an artefact in use, which is a description of the use of the artefact in an illustrative or real-life case, also called “proof of concept”.

The fifth sub-process, evaluate artefact, determines how well the artefact supports the solution to the problem, taking into consideration the solution objectives (input) and info on an artefact in use (input). The result is info on an evaluated artefact (output).

Hevner et al (2004) have identified a number of design evaluation methods for design science research, some of which are used in this thesis. The evaluation methods used in this thesis are:

- Action research – the artefact has been applied in a real-life organisation in order to identify its benefits and drawback. The researchers have participated in the design of the artefact together with IT providers and/or IT users
- Action research and semi-structured interviews – same as above but the researchers have also interviewed the IT providers and/or IT users about the benefits and drawback of the designed artefact
- Informed argument – a convincing argumentation for the artefact’s benefits is provided, preferably by using information from the knowledge base

The sixth sub-process, communicate artefact knowledge, is communication on the artefact to the research community and to practitioners. The communication could be carried out using papers, slides, videos, presentations and demos. The input to this sub-process comes from all the other sub-processes, and the result will be artefact knowledge (output).

3.2 The Research Processes of the Thesis

In this section, the governance and operational research processes behind the thesis are described according to the TDSRP, see previous section. The governance research processes are described in form of text, and the operational research processes are described in the form of both text and graphs, see Figures 9, 10, 11, 12, 13 and 14. Note that in order to reduce the clutter in the figures, not all the outputs/inputs from the TDSRP in Figure 8 are visualised.

The first research process

The *first research process* is the process behind Paper 1 and Appendix 1. It aims to achieve sub-goal 1: “Propose methods for designing models of business processes that support the fulfilment of enterprise goals in the setting of a value network”. Below, the operational research process is first described and then the governance process.

The *operational research process* (see Figure 9) is addressing the following refined problem: “How to design health care processes that enable new and innovative ways of collaboration among health care providers and patients”. The artefact designed in the research process was a method for identifying innovative actions for collaboration among actors in a health care value network. The research methods used were action research and conceptual analysis. The artefact was demonstrated by using an illustrative example (Paper 1) and by applying a variant of the artefact in a real-life case (Appendix 1). For

the evaluation of the artefact an *informed argument* was used (Paper 1). In Appendix 1, another evaluation is described using *action research and semi-structured interviews*, although the artefact evaluated in Appendix 1 was a variant of the artefact described in Paper 1. The theoretical foundations used in the operational research process were *health-care domain knowledge, e3 value model, the REA pattern, and the business motivation model (BMM)*.

The *governance research process*, steering the operational research process described above, was part of a larger governance research process, the one in the REMS project, described in Section 3.3. The overall research method used in the REMS project was action research. More specifically, researchers, health care providers (i.e. IT users) and an IT provider were collaborating in order to design a new service-oriented IT system supporting a referral process, and to design method support for the design and development of service-oriented IT systems. The collaboration resulted in a list of problems with the existing referral process. One of these problems was refined and the objectives of the solution were specified. To solve the problem, the researchers decided to design a method (artefact) based on value and goal models. First, a draft of the method (artefact) was designed and applied in participative modelling sessions with the health care providers and the IT provider. Based on the experiences of these sessions a refined version of the method was designed. Two variants of the method have been developed by the researchers – one to identify actions (Paper 1) and one to identify e-services (Appendix 1). The variant described in Appendix 1 was evaluated using action research and semi-structured interviews. The interviews were carried out with the CEO of the hospital and two system designers from the IT provider.

The second research process

The *second research process* is the process behind Paper 2 and 3. It aims at achieving sub-goal 2: “Propose methods for designing models of generic and reusable business processes that support the fulfilment of enterprise goals”. Below, the operational research process is first described and then the governance process.

The *operational research process* (see Figure 10) is addressing the following refined problem: How to make use of best practices for both well-structured and loosely structured business processes? This includes ensuring that the process from best practices has the same nature as the process under reengineering, and that such a “best-practices” business process can be found in a process library. The artefact designed in the research process was a method for creating business process patterns for reusing best practices. The suggested artefact was based on the state-flow technique. The research method used was conceptual analysis. The artefact was demonstrated by using an illustrative example (Paper 2) and by applying part of the artefact in a real-life case (Paper

3). For the evaluation an *informed argument* was used. Another evaluation is described in Paper 3. However, the evaluation in Paper 3 was focused on demonstrating the use of the state-flow technique in a real-life case, rather than evaluating the artefact for creating business process patterns. That is, the artefact is only partly evaluated in Paper 3. The demonstration/evaluation of the state flow technique in Paper 3 was carried out using the research method *action research*. The theoretical foundations used in the research process were *process engineering knowledge, the state-flow technique, and lobbying domain knowledge*

The *governance research process*, steering the operational research process described above, was part of a larger governance research process, the one in the INKA project, described in Section 3.3. The overall research method used in the INKA project was action research, but the research method used in the operational process described above was mainly conceptual analysis. The researchers used their theoretical knowledge on the state-flow technique and process engineering in general to design the artefact (method). The designed artefact (method) was partly evaluated during the design of a prototype of an IT system supporting a lobbying process (Paper 3), which was carried out as part of the INKA project. More precisely, it was the application of the state-flow technique that was demonstrated. The evaluation/demonstration was carried out using the action research method, which included cooperation between researchers, IT providers, and domain experts on lobbying (i.e. IT user).

The third research process

The *third research process* is the process behind Paper 4. It aims at achieving sub-goal 3: “Propose methods for designing models of e-processes that support the alignment of IT systems with business processes”. Below, the operational research process is first described, and then the governance process.

The *operational research process* (see Figure 11) is addressing the following refined problem: How to design e-processes that are well-structured, complete and understandable for the involved stakeholders as well as how to design e-processes that can manage data inconsistencies in existing IT systems? The artefact designed in the research process was a method for designing e-services ensuring that the designed e-processes are well-structured, understandable and of high quality. The research methods used were action research and conceptual modelling. The artefact was demonstrated by using an illustrative example. For the evaluation an informed argument was used. The theoretical foundations used in the research process were telecom domain knowledge, Enterprise Application Integration (EAI) knowledge, process engineering knowledge, the process modeling language BML, and speech act theory.

The governance research process, steering the operational research process described above, was part of a larger governance research process, the one in the Process Broker project, described in Section 3.3. The overall research method used in the Process Broker project was action research. More specifically, researchers, business and IT analysts at the IT provider, and managers at a telecom company (i.e. IT users) were collaborating in order to design e-processes. The e-processes aimed at integrating people and IT system in a mobile telecom system at the telecom company, including customers, administrative and technical users, and administrative and technical IT applications. Based on problems identified during the design of the e-processes, the researchers used their theoretical knowledge on process engineering, EAI and speech act theory to create the artefact (method). The artefact was evaluated using an informed argument.

The fourth research process

The *fourth research process* is the process behind Paper 4. It aims at achieving sub-goal 3: “Propose methods for designing models of e-processes that support the alignment of IT systems with business processes”. Below, the operational research process is first described and then the governance process.

The *operational research process* (see Figure 12) is addressing the following refined problem: How to integrate health care organisations and their IT systems using e-processes executed in BPMS in an effective and secure way? The artefact designed in the research process was a method for designing e-services to be executed in BPMS. The research method used was *action research*. The artefact was demonstrated describing its application in a real-life case. The evaluation was carried out using *action research and semi-structured interviews*. The theoretical foundations used in the research process were *health care domain knowledge, process engineering knowledge, EAI knowledge, the security specification ISO 17799, and the process modeling language BML*.

The *governance research process*, steering the operational process described above, was part of a larger governance research process, the one in the Vita Nova project, described in Section 3.3. The overall research method used in the Vita Nova project was action research. More specifically, researchers, health care providers (i.e. IT users) and IT providers were collaborating in order to design a method for designing e-processes for integration of personnel, patients and IT systems in health care. The method was evaluated using action research & semi-structured interviews with the researchers involved in the business analysis, the IT providers designing the e-processes, and the health care personnel using a prototype of the e-processes executed in the BPMS.

The fifth research process

The *fifth research process* is the process behind Paper 6. It aims at achieving sub-goal 4: “Propose methods for evaluating the extent to which business processes are aligned with enterprise goals and IT systems”. Below, the operational research process is first described and then the governance process.

The *operational research process* (see Figure 13) is addressing the following refined problem: How to identify and design KPIs for health-care organisations, since designing KPIs for health care is a time-consuming and error-prone task? The artefact designed in the research process was a method for identifying and designing patient-oriented KPIs in health care. The research method used was conceptual analysis. For the evaluation *informed argument* was used. The theoretical foundations used in the research process were health-care domain knowledge, performance management and *Key Performance Indicator (KPI) knowledge*, *e3 value model*, *Open-EDI phases*, *CONTSYS*, and *the service quality model SERVQUAL and its predecessor*.

The governance research process was an indirect result of the REMS project, described in Section 3.3. During the REMS project, solutions for measuring the performance of the referral process were discussed. After the REMS project was ended, researchers designed a method for designing KPIs for health care. For designing the artefact, the researchers used their theoretical knowledge on performance management and KPIs, e3 value model, Open-EDI phases, health care information specification CONTSYS, and the service quality model SERVQUAL and its predecessor. The artefact was demonstrated by using an illustrative example. The artefact was evaluated using an informed argument.

The sixth research process

The sixth research process is the process behind Paper 7. It aims at achieving sub-goal 4: “Propose methods for evaluating the extent to which business processes are aligned with enterprise goals and IT systems”. Below, the operational research process is first described, and then the governance process.

The *operational research process* (see Figure 14) is addressing the following refined problem: How to identify and analyse problems related to the e-services impact on business processes of the customers, as well as suggest tentative solutions? The artefact designed in the research process was a method for identifying and analysing problems related to the e-services’ impact on business processes of the consumers. The research method used was conceptual analysis, action research including semi-structured interviews with a business developer at the Swedish Tax Agency, and semi-structured interviews with a number of consumers of the e-services for tax declaration. The artefact was demonstrated describing its application in a real life case. For the evaluation

informed argument was used. The theoretical foundations used in the research process were *tax declaration domain knowledge, process engineering knowledge, a four-aspect process framework, and service oriented architecture (SOA) knowledge*.

The *governance research reprocess*, steering the operational research process described above, was part of a larger governance research process, the one in the SamMET project, described in Section 3.3. The overall research method used in the SamMET project was action research. More specifically, researchers and business developers at the Swedish Tax Agency collaborated in order to identify why the e-service for tax declaration was not used as much as expected. Meetings between researchers and business developers at the Swedish Tax Agency resulted in a list of problems with the existing e-service for tax declaration. One of these problems became the input for the operational research process described above, i.e. the initial problem. To solve the problem the researchers decided to design a method (artefact) based on an existing four-aspect process framework for business process analysis, which the researchers have used before. The researchers also created an instrument for identifying tentative solutions. To identify the business processes at the Swedish Tax Agency as well as at the consumers of the e-service, semi-structured interviews were carried out, both with a business developer at the Swedish Tax Agency and with eleven consumers of the e-service. For the evaluation an informed argument was used.

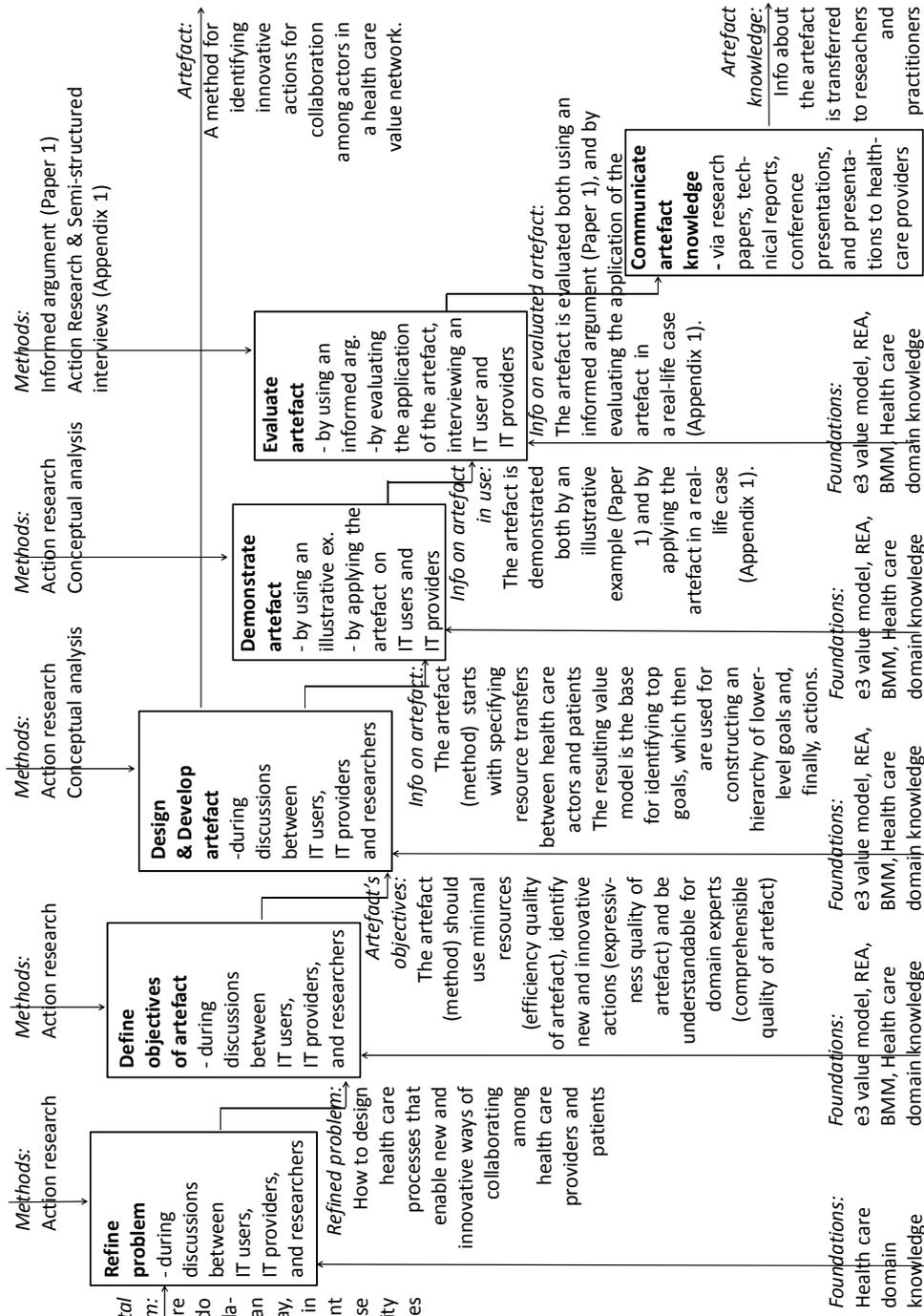


Figure 9. Operational research process 1 for achieving sub-goal 1 of the thesis.

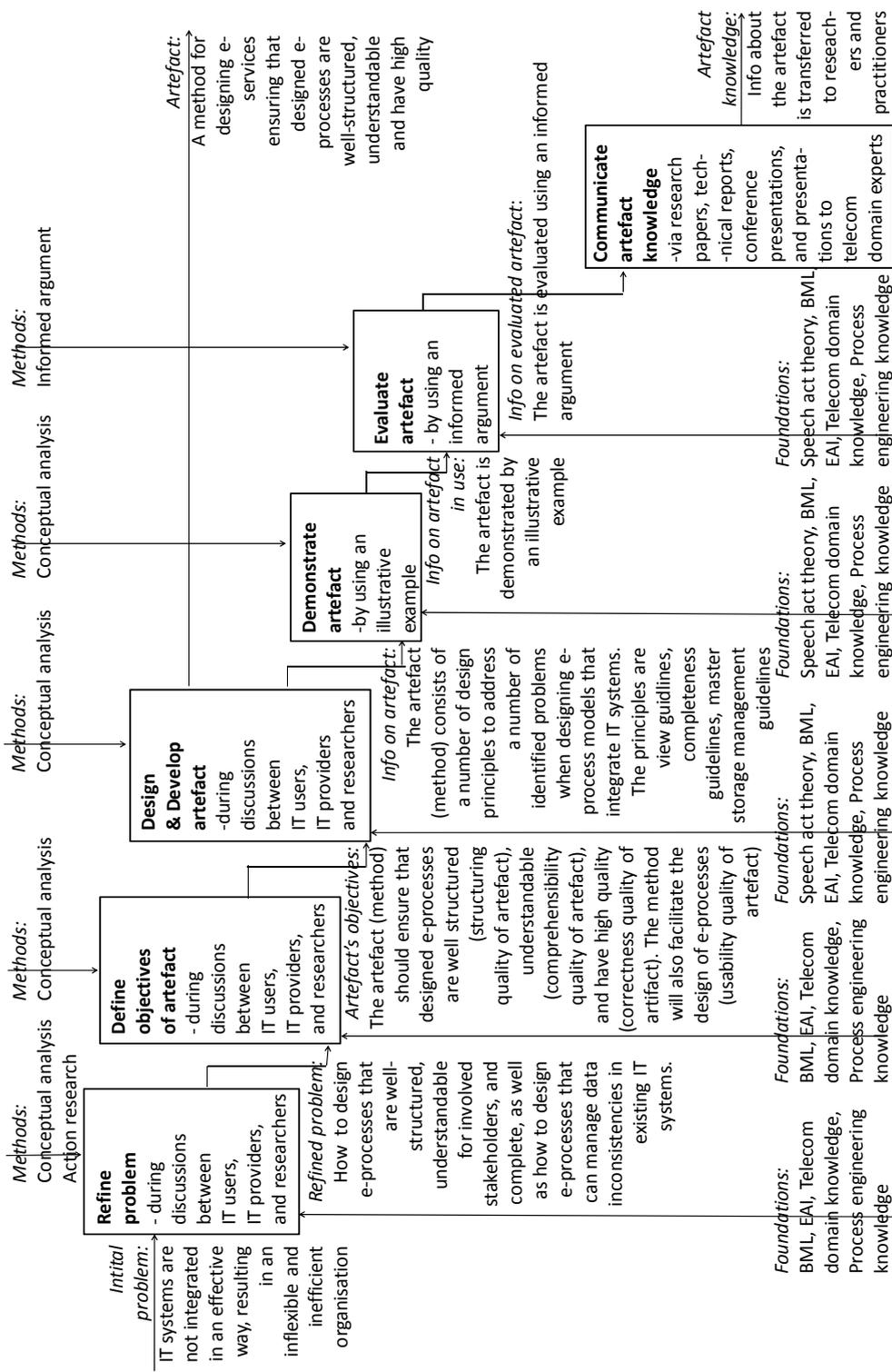


Figure 11. Operational research process 3 for achieving sub-goal 3 of the thesis.

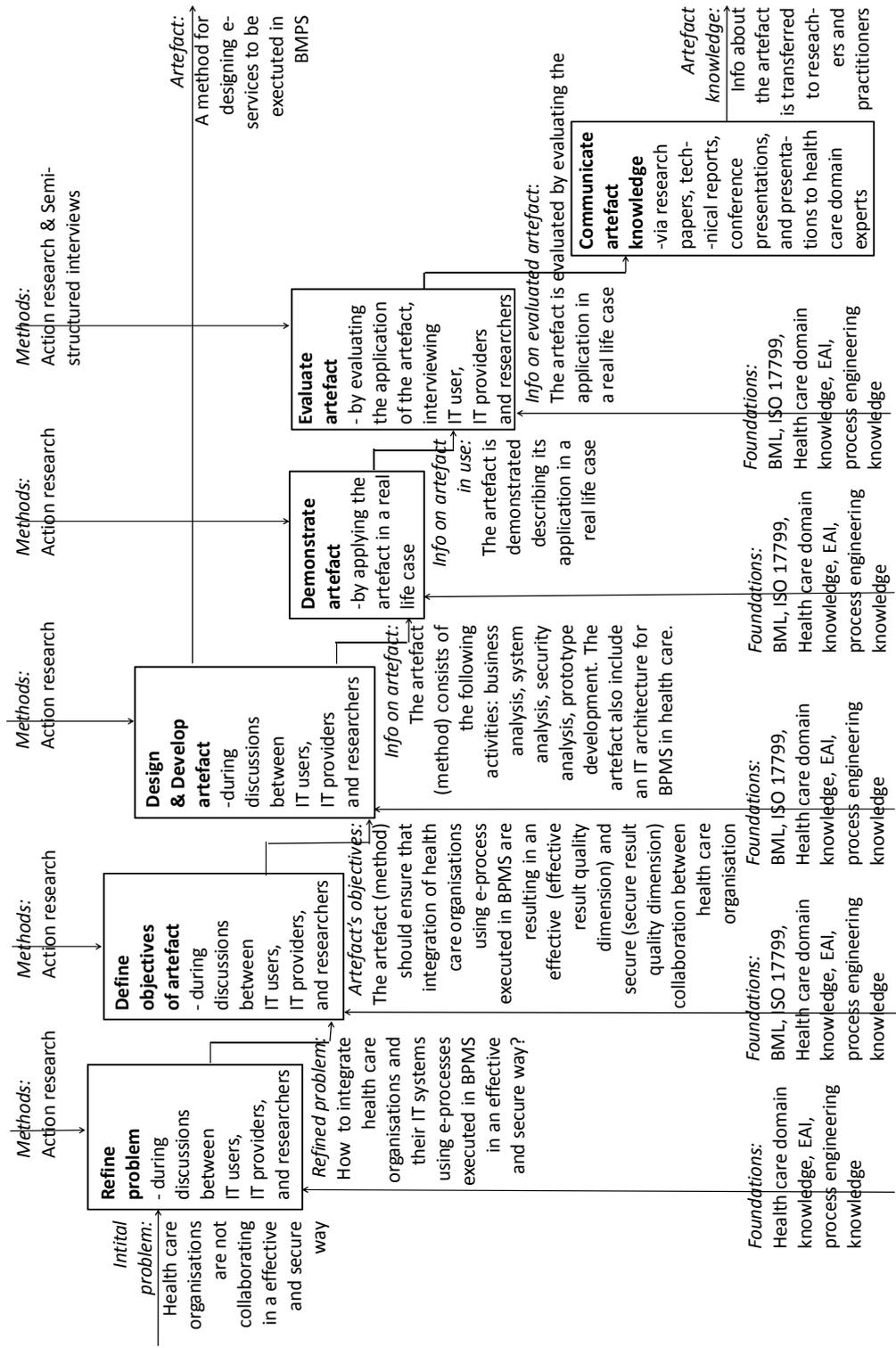


Figure 12. Operational research process 4 for achieving sub-goal 3 of the thesis.

3.3 Research Projects

The research presented in this thesis is based on research projects which the author of the thesis have participated in. In this section, the research projects are described.

The Process Broker project

The goal of the Process Broker project was to investigate BPMS (in the project called Process Brokers) technology and methodology, in particular implementation architectures for BPMS, description techniques for e-processes, and methods for process and application integration. A prototype of a BPMS was designed, implemented, and applied to support a mobile telecom system of a leading European telecommunication company. The prototype aimed at integrating users, such as customers, administrative and technical personnel, and around 20 technical and administrative IT applications. Over 30 e-processes were modelled in the project for execution in the BPMS. The designed e-processes automated manual activities carried out by customers and administrative personnel, and the e-processes made it possible to combine existing mobile telephone services in order to create new services.

The Process Broker project was carried out between 1999-01-01 and 2001-08-30. Project participants were an IT provider, Viewlocity (today Visuera Integration AB); an IT user, which was a leading European telecommunication company; and researchers from the Department of Computer and Systems Sciences (DSV) at Stockholm University/Royal Institute of Technology. The project was funded by the Swedish Agency for Economic & Regional Growth (NUTEK).

The Process Broker project is the empirical basis for paper 4 presented in this thesis.

The Vita Nova project

The goal of the Vita Nova project was to develop a methodology for, and to investigate the potential of, an IT architecture for integrating healthcare organisations based on BPMS technology. A prototype was developed representing a patient e-process for leg ulcer. The reason for choosing this particular illness was that the regional hospital had leg ulcer as one of its specialities. Since the project was limited in budget and time (one year), no real integration between the users and IT systems was implemented, i.e. the communication between the users and IT systems of different healthcare organisations was only simulated in the BPMS.

The project was carried out between 2002-07-01 and 2003-09-30. Project participants were two IT providers, Visuera Integration AB and Unicom Care

AB; IT users, which were two municipal home healthcare organisations in Skövde and Falköping, a regional primary care organisations (Hentorp Primary Care), a specialist department at a hospital (Skaraborg Hospital) and a laboratory company (Capio Diagnostik); and the researchers from the Department of Computer and Systems Sciences (DSV) at Stockholm University/Royal Institute of Technology and Skövde University. The project was funded by the Knowledge Foundation and the Vårdal Foundation. A follow up project, Vita Nova Home, was funded by the Swedish Agency for Innovation Systems (VINNOVA).

The Vita Nova project is the empirical basis for paper 5, presented in this thesis.

The INKA project

The goal of the INKA project was to work out techniques for developing an integrated process and knowledge management system, and investigate effects of introducing such a system in operational practice, i.e. measure effects on productivity, internal cooperation, and democracy in organisational life. The motivation for integrating process and knowledge management was the experiences that knowledge management systems are not used as much as expected if they are not, more or less, seamlessly incorporated in everyday business activities. An integrated process and knowledge management system was developed and applied at a non-profit interest organisation. The system was based on the state-flow technique.

The project was carried out between 2003-09-01 and 2006-08-31. Project participants were an IT provider, Ibissoft AB; an IT user, Association of Tenants (HGF), Region West, Sweden; and researchers from the Department of Computer and Systems Sciences (DSV) at Royal Institute of Technology/Stockholm University. The project was funded by the Swedish Agency for Innovation Systems (VINNOVA).

The INKA project is the empirical basis for paper 2 and 3, presented in this thesis.

The REMS project

The goal of the REMS project was to improve the management of health care referrals sent between an eye specialist clinic at a hospital, primary health care units, opticians, and private eye specialists. Health care referral is one of the key instruments used when health care providers collaborate in the treatment of patients. However, the referral process was often non-efficient, not patient focused, and the information quality of the referrals sent and received was low. Therefore, the REMS project aimed at designing a service oriented IT system supporting an efficient, high quality and innovative way of collaborating in the

referral process. The project also aimed at designing method support for designing and developing service oriented IT systems. Value network models, goal models and different kinds of process descriptions were important means for designing method support for designing and developing the IT system.

The project was carried out between 2005-08-31 and 2007-12-31. The project participants were an IT provider, OOPix Consultancy; the IT users, S:t Eriks Eye Hospital, primary care organisations, opticians and private eye specialists; and researchers from the Department of Computer and Systems Sciences (DSV) at Royal Institute of Technology/Stockholm University. The project was funded by the Swedish Agency for Innovation Systems (VINNOVA), the Stockholm County Council, and the S:t Erik's Eye Hospital.

The REMS project is the empirical basis for paper 1 and 6, presented in this thesis.

The SamMET project

The goal of the SamMET project was to develop methods for customer interactive and innovative service design. The project addressed the need for increased customer participation and systematic ways of working in service design. The main result of the project was a method framework applicable for e-service design.

The project was carried out between 2008-09-01 and 2010-12-31. The project participants were three e-service providers, Ericsson, Scandinavian Airlines (SAS), and the Swedish Tax Agency; and researchers from three universities, Stockholm University, Linköping University and University of Skövde. The project was funded by the Swedish Agency for Innovation Systems (VINNOVA).

The SamMET project is the empirical basis for paper 7, presented in this thesis.

4 Paper Summary

In this chapter, the papers presented in this thesis are summarised, including descriptions of the papers' main research contribution and the author's main contribution to the papers. The relations between the sub-goals of the thesis, the research processes and the papers are described in Figure 15.

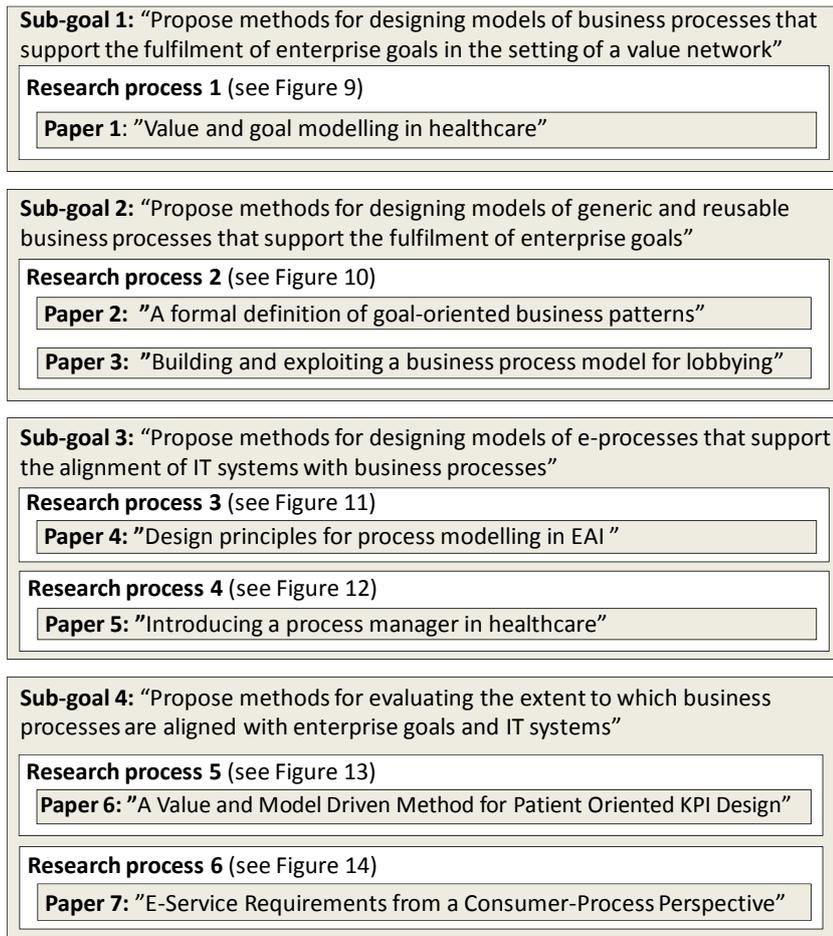


Figure 15. The relation between the sub-goals of the thesis, the research processes (presented in Section 3.2) and the papers.

Paper 1

Henkel, M., Johannesson, P. and Perjons, E. (2007) Value and goal modelling in healthcare. In: *Proceedings of the Twelfth International Symposium on Health Information Management Research (iSHIMR 2007)*, 18–20 July 2007, Sheffield, UK, ISBN: 0-903522-40-3, pp. 43–50.

The problem that the paper addresses

Health care is a complex sector where different health care providers need to collaborate in order to increase values for the patients. However, health care providers do not collaborate in an effective way, resulting in inefficient resource use and health care quality issues. Therefore, there is a need for an instrument (artefact) that enables new, innovative and effective ways of collaboration among health care providers and patients.

The goal of the paper

The goal of the paper is to provide a method (artefact) for identifying a set of new and innovative actions in health care processes (i.e. health care business processes) supporting effective collaboration among health care providers and patients. The identified actions are based on goals and configuration of a value network. Thus, there will be traceability between values, goals and actions.

The solution described in the paper

The method (the artefact) combines and extends two types of high-level enterprise model, value models and goal models, in order to identify new and innovative actions, which can be introduced into business processes. A set of guidelines supports the use of the method.

The method starts by specifying a value model, describing transfers of economic resources between health care actors, such as “investigation”, “eye treatment”, “patient fee”, “referral to specialist eye treatment”, and “patient responsibility”. These economic resources are categorised into “goods”, “service”, “information”, “money”, and “voucher”. The value model also describes the intended effects as results of the transfers of the economic resources. Examples of such intended effects are: “better health state”, “knowledge of health condition”, and “increased feeling of safety”. In the value model, each economic resource transfer is to be related to one economic resource, one economic resource category and one or several intended effects. For example, an economic resource transfer can consist of an eye treatment (i.e. economic resource), which is a service (i.e. economic resource category)

that aims at resulting in a better health state (i.e. intended effect), and an increased feeling of safety (i.e. intended effect).

The economic resources and intended effects specified in the value model are, together with so-called resource enhancers, the basis for identifying top goals. A resource enhancer expresses a desirable feature of an economic resource itself, or the way in which an economic resource is transferred to the recipient actor. Examples of resource enhancers are “fast”, “high quality”, “flexible”, “low cost”, and “secure”. More specifically, top goals are created by combining economic resources and resource enhancers, and by combining economic resources and intended effects. Examples of such created top goals are: “fast eye treatment” (resource enhancer + economic resource) and “eye treatment shall give rise to an increased feeling of safety” (economic resource + intended effects).

The identified top goals will be on a very generic level and will not directly support any actions to take. Therefore, the top goals are decomposed into a hierarchy of goals on lower levels until concrete actions are identified. This decomposition is supported by a set of goal and action refinement guidelines, which are categorised into three types of guideline: guidelines supporting the identification of goals or actions regarding the transfer of resources between two actors; guidelines supporting the identification of goals or actions regarding the internal actions of one single actor; and guidelines supporting the identification of goals or actions regarding architecture and information provision within the entire value network. Finally, a number of candidate actions are identified, which can be introduced into health-care processes.

Demonstration and evaluation of the solution

The method is demonstrated both by using an illustrative example of how the method could be applied, based on a real-life case from the eye health-care sector (in Paper 1). The method is evaluated both by using an informed argument (in Paper 1). Another variant of the method in which innovative e-services instead of actions were identified, have been evaluated. This evaluation has also relevance for this paper since the first method steps are the same as in the both variants of the method. The evaluation is presented in Appendix 1. In the evaluation presented in Appendix 1, semi-structured interviews were carried out with a health-care administrator (i.e. the CEO of the public specialist eye-care hospital) and two system developers at the IT provider.

Concepts in focus

The concepts from the conceptual framework (see Section 2.2) that are in focus in paper 1 are marked as grey in figure 16.

The thesis author's contribution to the paper

The thesis author contributed to all the parts of the paper. The author's main contributions are the method for combining value and goal models in order to identify actions, and the definitions of the extended notion of the value and goal modelling techniques. The thesis author's contribution to the paper corresponds to more than 25 percent.

Other papers related to sub-goal 1 by the by the thesis author

- Henkel M., Johannesson P.,and Perjons E. (2011) An Approach for E-service Design using Enterprise Models, *International Journal of Information System Modeling and Design (IJISMD)*, Vol. 2, Issue No. 1
- Henkel, M., Johannesson, P.,and Perjons, E. and Zdravkovic, J. (2007) Value and goal driven design of e-services. In: *The IEEE International Conference on e-Business Engineering (ICEBE'07)*, October 2007. IEEE Computer Society Press, 978-0-7695-3003-1. pp. 295–303
- Henkel, M., Perjons, E., and Zdravkovic, J. (2006) A value-based foundation for service modelling. In: *The European Conference on Web Services (ECOWS'06)*, December 2006, Zurich, Switzerland. IEEE Society Press, 0-7695-2737-X. pp. 129–137
- Henkel, M., Perjons, E., and Zdravkovic, J. (2007) Towards guidelines for the evolution of e-service environments. *International Journal of Public Information Systems*, 3, pp. 183–200

Paper 2

Andersson, B., Bider, I., Johannesson, P., and Perjons, E. (2005) Towards a formal definition of goal-oriented business patterns. *Business Process Management Journal (BPMJ)*, 11(6), Emerald Group Publishing Ltd., UK

The problem that the paper addresses

The focus on business process management has increased the interest in using best practices for business processes in order to create effective and efficient business processes. However, two problems arise in connection to using best practices: how to find a best practice that suits particular purposes, and how to ensure that the process from the best practice has the same nature as the process under reengineering. Therefore, there is a need for an instrument (artefact) that enables the comparison of business processes, both well-structured and loosely structured business processes. Loosely structured business processes are

processes for which it is difficult to predetermine the order of the activities because of their ad-hoc nature.

The goal of the paper

The goal of the paper is to provide a method (artefact) for constructing a business process pattern that ensures that the process from the best practice has the same nature as the process under reengineering as well as support annotation, so that an appropriate pattern can be found in a pattern library. Thereby, effective and efficient business processes can be better reused.

The solution described in the paper

The method (artefact) is based on a state-flow technique and a definition of a business process pattern, which makes it possible to compare and annotate business processes, both well-structured and loosely structured.

The paper starts by specifying a set of requirements for the business process pattern for comparing and annotating business processes. Based on these requirements, widespread business process modelling techniques are analysed and categorised. According to the analysis, the state-flow technique is most suited for developing a business process pattern if both well-structured and loosely structured business processes need to be addressed.

In the state-flow technique, the focus of a business process is on its state changes, instead on the order of the activities. This allows you to abstract more easily away from the order in which the activities are applied, which is necessary in loosely structured business processes. More specifically, in the state-flow technique a business process is viewed as a trajectory in a constructed state space. A state space consists of multiple dimensions, where each dimension represents a process attribute, e.g. ordered, delivered, invoiced or paid. This means that a state of a process is represented as a complex structure that includes a set of attributes and values of the attributes. A process state is aimed to show how much has been done to achieve an enterprise goal of a process, and how much is still to be done. A business process has an enterprise goal, which is a surface in the state space (i.e. a specific set of attributes and their values). For example, the goal of a sales process may be that the ordered products are delivered and that the invoice for the ordered products is paid. That is, a goal can be viewed as a set of conditions that have been fulfilled before a process can be considered as finished. Furthermore, a business process instance has valid movement in the state space to reach the goal. For example, a process instance's valid movement in a state space can be that the order is first placed (a dimension), that the order may be changed or not, that the ordered products are delivered (a dimension), and that the order is invoiced (a dimension) as well as paid (a dimension). Activities such as "change order", "order products" and "deliver products" can be carried out in any order, only certain states have to be reached. The process is driven forward

through the activities carried out. When an activity is carried out, the “generalised” state of the process is changed.

The business process pattern definition is based on the state-flow technique and consists of three components: state space, goal and valid movements towards the goal. Two business processes are considered similar if: the state spaces have a similar structure of dimensions (i.e. similar process attributes), the goals are similar, i.e. the goals have similar surfaces in the state space (i.e. a similar set of attributes and their values), and they have the same kind of valid movements in the state space towards the goal.

The method (artefact) for constructing business patterns is then presented in the paper. First, a state space suitable for representing the development of the process in time is defined. For example, the identified dimensions (i.e. process attributes) for the management of the ground document in a decision-making process can be requested, obtained, reviewed and accepted as a ground document. Second, the process’s goal as a surface in the state space is defined. For example, the document has to be reviewed and accepted. Third, all possible valid movements towards the goal are defined. For example, a document could after being reviewed be accepted, partially accepted or not accepted.

Demonstration and evaluation of the solution

The method is demonstrated by using an illustrative example of how the method could be applied, based on a real-life case in decision making in the administration of elderly care in a municipality. The method is evaluated by using an informed argument. Note that the method is also partly evaluated by applying the method to a real-life case designing a lobbying process, which is described in Paper 3. More precisely, it is the application of the state-flow technique being demonstrated in Paper 3.

Concepts in focus

The concepts from the conceptual framework (see Section 2.2) being in focus in paper 2 are marked as grey in figure 17.

The main research contributions of the paper

The main research contribution is the categorisation of widespread business process modelling techniques, a list of requirements for business process modelling techniques for designing a pattern, a description of the constructed process pattern technique fulfilling the requirement, the definition of the business process pattern, and an illustrative example from a real life case using the method.

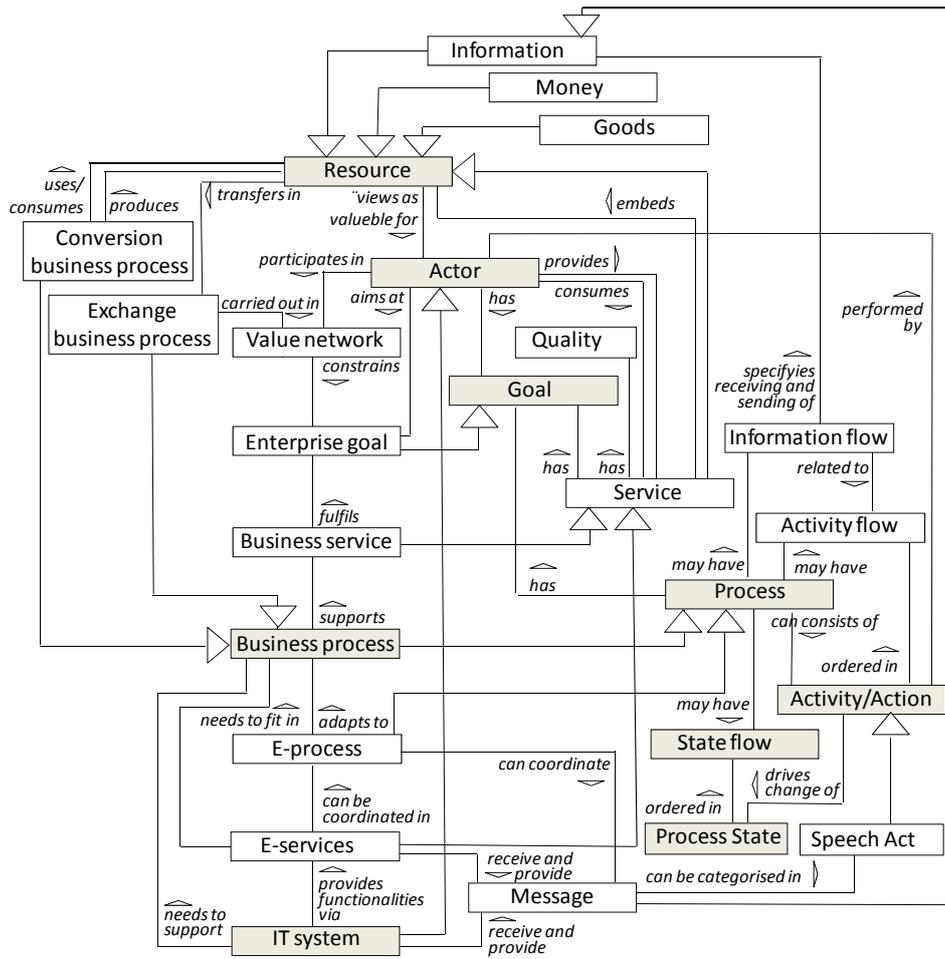


Figure 17. The concepts from the conceptual framework that are in focus in paper 2 and 3.

The thesis author's contribution to the paper

The thesis author contributed to all the parts of the paper. The thesis author's contribution to the paper corresponds to about 25 percent.

Paper 3

Perjons, E. A., Bider, I., and Andersson, B. (2007) Building and exploiting a business process model for lobbying: Experience report. *Communications of the IIMA (CIIMA)*, Vol. 7, No. 3, The International Information Management Association, pp. 1-14

The problem that the paper addresses

A method for designing and implementing a process model for a loosely structured process, a lobbying process, has been applied in a real-life organisation. The purpose was to optimise the organisation's way of working with lobbying, i.e. influencing the decisions of politicians and managers, as well as developing an IT system that aims at supporting such a process. The designed and implemented process model was based on a state-flow technique, in which a business process is seen as driven forwards through a set of stipulated states until an enterprise goal has been reached. The state-flow technique is especially suitable for loosely structured business processes, i.e. processes for which it is difficult to predetermine the order of the activities. However, the application of the method needs to be evaluated in order to refine the method. Therefore, experiences of the method applications need to be gathered.

The goal of the paper

The goal of the paper is to describe the results and experiences of applying a method (artefact) in a real-life organisation for designing and implementing a process model for a loosely structured process. The method is based on the state-flow technique.

The application of the solution

First, the paper describes the state-flow technique, which is the theoretical basis for the process model. Second, the paper describes the method used for designing the business process model, including collaboration between domain experts and business analysts. Third, the resulting lobbying process model, and its supporting IT system are described. Fourth, the experiences of implementing and introducing the lobbying process and its supporting IT system in a real-life organisation are described. The experiences showed that the implementation was difficult to perform. The most fundamental problem was the change from a functional-oriented to a process-oriented way of working.

Concepts in focus

The concepts from the conceptual framework (see Section 2.2) that are in focus in paper 3 are marked as grey in figure 17.

The main research contributions of the paper

The main research contributions are the description of the resulting lobbying process based on the state-flow technique, and the experiences of implementing and introducing the process, and its supporting IT system into a real-life organisation.

The thesis author's contribution to the paper

The author contributed to all the parts of the paper, and participated in both the design and the implementation of the business process model in the real-life organisation. The thesis author's contribution to the paper corresponds to more than 50 percent.

Other papers related to sub-goal 2 by the by the thesis author

- Andersson, B., Bider, I., and Perjons, E. (2005) Analyzing loosely structured business processes using a minimal software prototype. In: Khosrow-Pour, M. (ed.) *Managing Modern Organization with Information Technology, IRMA 2005 Proceedings, International Conference*, May 15–18, 2005, San Diego, California, USA. Information Resources Management Association, Idea Group Publishing.
- Andersson, B., Bider, I., and Perjons, E. (2005) Business process support as a basis for computerized knowledge management, In: Althoff K.-D., Andreas Dengel, Bergmann R., Nick M., Roth-Berghofer, T (eds) *Professional Knowledge Management*, Lecture Notes in Artificial Intelligence (LNAI), Vol. 3782. Springer Verlag, pp 542-554.
- Bider, I., Johannesson, P., and Perjons, E. (2002) Goal-oriented patterns for business processes. In: Bider, I. & Johannesson, P. (eds.) *Proceedings of the HCI'02 Workshop on Goal-Oriented Business Process Modelling (GMBP'02)*, 2 September, London. CEUR-WS.org

Paper 4

Johannesson, P. and Perjons, E. (2001) Design principles for process modelling in enterprise application integration. *Information Systems*, Vol. 26, Elsevier Science Ltd, pp. 165–184

The problem that the paper addresses

In order to create flexible and integrated IT support, organisations are introducing BPMS (in the paper called process brokers), which integrate and align IT systems to the business processes of the organisation. Such an integration requires the use of e-processes that are to be executed by the BPMS. However, creating e-processes for BPMS is a complex design activity. Therefore, there is a need for adequate method support (i.e. an artefact) to create well-structured, understandable and high-quality e-processes.

The goal of the paper

The goal of the paper is to provide method support (artefact) in the form of principles for design, validation, and presentations of e-processes, aligning the IT systems to the business processes of an organisation. Such method support will create well-structured and easily understandable e-process models for the involved stakeholders; the identification of incomplete e-process models; and the management of data inconsistencies in the different IT systems that are to be integrated.

The solution described in the paper

The method support makes use of a number of design principles to address a number of identified problems when designing and presenting e-process models integrating IT systems. The design principles are view guidelines, completeness, and guidelines for managing redundant storage.

View guidelines are guidelines that obtain a series of views of e-processes starting from a customer-oriented view on the business level, then adding more and more technical details. Each view is an extension of the previous one, either through adding sub-processes, or through introducing new components into the existing diagrams. The view guidelines are based on an e-process classification consisting of: the customer process, describing interaction with customers; interface processes, one for each IT system, describing interaction with IT systems; synchronisation processes, synchronising interface processes with each other, and synchronising interface processes and customer processes;

and maintenance processes, handling redundancy in the IT systems that are integrated.

Completeness guidelines are guidelines that support the identification of incomplete e-process models. The guidelines exploit the fact that messages typically occur in certain dialogue structures, such as request and confirmation. The guidelines use a message classification in the form of message types based on speech act theory. Examples of identified message types are service request, service confirmation, reservation request, reservation confirmation, booking request, booking confirmation, service promise, cancel reservation, and cancel booking.

Guidelines for managing redundant storage are guidelines supporting the management of a master storage. Such storage has a complete and correct set of data for all the integrated IT systems and can be used to manage inconsistencies in the integrated IT systems as well as support fast access to data that otherwise require different IT systems to be invoked.

Demonstration and evaluation of the solution

The method is demonstrated by using an illustrative example of how the method could be applied, based on a real-life case from the telecom sector. The method is evaluated by using an informed argument.

Concepts in focus

The concepts from the conceptual framework (see Section 2.2) that are in focus in paper 4 and 5 are marked as grey in figure 18

The main research contributions of the paper

The main research contributions are the design principles, i.e. view and completeness guidelines, and guidelines for managing redundant storage.

The thesis author's contribution to the paper

The thesis author's main contribution is the description of the problem that the paper address, the description of the case to which the process patterns were applied, and the construction of the view guidelines. The thesis author's contribution to the paper corresponds to about 50 percent.

executing e-processes. However, the potential of e-processes and BPMS in healthcare need to be investigated in real-life cases.

The goal of the paper

The goal of the paper is to evaluate the use of BPMS executing e-processes in healthcare in order to identify opportunities and problems from different healthcare actors' perspective.

The application of the solution

In the project, e-processes were designed and applied in a BPMS integrating health care personnel from three different types health care organisations: home health care, primary care, and a specialist department at a hospital.

First, the paper describes the IT architecture of the implemented prototype of the BPMS, including the relations between e-processes, business processes, and IT systems.

Second, the paper describes the activities carried out in the project: the business analysis, the systems analysis, the security analysis, prototype development, and the project evaluation. In the business analysis, participative modeling sessions were carried out where business analysts and health care personnel together specified existing health care processes, including the information sent and received in the processes. The system analysis analysed the existing IT systems and how they could be integrated by the means of a BPMS. The security analysis investigated security issues by interviewing health care personnel, IT personnel and the suppliers of the IT systems. In the prototype development activity, e-processes were designed and implemented in a prototype of a BPMS, which was tested by health care personnel at three different health care organisations: home health care, primary care, and a specialist department at a hospital. The experiences of using the method in a real-life case were gathered in the project evaluation activity, by interviewing healthcare personnel, system developers, and business analysts.

Third, the paper describes results from the project evaluation, i.e. the experienced opportunities and problems from the application of the prototype of the e-processes. The result of the evaluation was structured according to the following issues: availability of patient information, work routines, process management, security management, IT systems integration. The evaluation showed that current information about patients can be transferred automatically between healthcare organisations using the BPMS, resource intensive manual tasks can be replaced with automated tasks, and long term process monitoring and quality assessment can be enabled. However, introducing a BPMS in healthcare requires ways to deal with security issues (security, ethics, and legality). The healthcare organisations involved in the project also show large differences in security awareness and IT maturity, which could obstruct the introduction of a BPMS.

Concepts in focus

The concepts from the conceptual framework (see Section 2.2) that are in focus in paper 4 and 5 are marked as grey in figure 18.

The main research contributions of the paper

The main research contributions are the presented steps of the method used in a real-life project and the suggested business and IT architecture as well as the result of the evaluation in which healthcare personnel, system developers and business analysts were interviewed.

The thesis author's contribution to the paper

The thesis author was the main contributor of the paper. The thesis author's contribution to the paper corresponds to about 50 percent.

Other papers related to sub-goal 3 by the thesis author

- Johannesson, P. and Perjons, E.(2000) Design principles for application integration. In: Wangler, B. and Bergman, L. (eds.) *Advanced Information Systems Engineering, 12th International Conference, CAiSE 2000*, Stockholm, Sweden, Proceedings. Springer Verlag, pp. 212-231
- Johannesson, P., Perjons, E., Wangler, B., and Åhlfeldt, R.-M. (2005) Design solutions for interoperability using a process manager. In: Konstantas, D., Bourrières, J-P., Léonard, M. and Boudjlida, N. (eds) *Interoperability of Enterprise Software and Applications*, Springer Verlag, pp. 397–408
- Perjons, E., Wangler, B., and Åhlfeldt, R.-M. (2006), Efficient and Secure Process and IT Integration in Healthcare, In Carlsson et al (eds.), *Knowledge in Organisations I*, Skövde University Studies in Informatics, ISSN 1653-2325, pp.11-20
- Wangler, B., Perjons, E. and, Åhlfeldt, R.-M (2003) Process oriented information systems architectures in healthcare, In: *Health Informatics Journal*, Vol. 9, No. 4, pp. 253–265

Paper 6

Perjons, E. and Johannesson, P. (2011) A Value and Model Driven Method for Patient Oriented KPI Design in Health Care, In: Fred, A., Filipe, J., Gamboa, H. (Eds.) *Biomedical Engineering Systems and Technologies, Third International Joint Conference, BIOSTEC 2010*, Valencia, Spain, January 20-23, 2010, Revised Selected Papers, Communications in Computer and Information Science, Vol. 127, Springer, pp.123-137

The problem that the paper addresses

Key performance indicators (KPIs) are a main instrument for governing and measuring an organisation's performance. However, designing KPIs in health care is time consuming and error prone, and still, important KPIs could be omitted. Therefore, there is a need for an instrument (artefact) supporting the identification and design of KPIs.

The goal of the paper

The goal of the paper is to propose a method (the artefact) for constructing a complete set of patient-oriented KPIs, i.e. KPIs from the patient's perspective. The method aims at systematically generating all the relevant KPIs from goals and service-quality dimensions. Thus, the method will support the completeness of KPIs as well as traceability between goals, service qualities and KPIs. All the relevant KPIs should be identified using minimal resources.

The solution described in the paper

The method (the artefact) makes use of a number of conceptual and standard models in order to generate patient-oriented KPIs. These generated KPIs are candidate KPIs, and the KPIs deemed most important should be selected for implementation.

The starting point of the method is to create a value model, describing transfers of economic resources in the form of services between health-care actors. The value model delimits the domain under consideration by identifying health-care actors and their services.

The method helps generating both technical and functional quality KPIs for the identified services. Technical-quality KPIs measure the clinical results of health diagnostic and therapeutic services. Technical-quality KPIs are generated by instantiating four generic KPI templates with the relevant health-care services and issues. The generic KPI templates are based on a small

number of top-level goals for technical quality, e.g. “Health care services should have positive effects on health issues”. For the identification of the relevant health-care services and issues, a standard services and issues model based on CONTSYS (a health-care information standard) can be used as a starting point.

Functional-quality KPIs refer to the manner in which the health care services identified in the value model are delivered to patients. Functional service quality includes aspects like facilities, hospital food, employee attitudes, responsiveness and cleanliness. Functional-quality KPIs are generated by applying a set of complementary services decomposed from each main service, and by applying a number of service-quality dimensions (e.g. employee attitudes, employee responsiveness) for each complementary service. The complementary services are adapted from the open-EDI standard, and examples of such services are service pre- and post-actualisation, for example, preparing and informing the patient about the result of the service. For the identification of service-quality dimensions, a standard service-dimension model is used, based on an existing service-quality framework, a predecessor to the service-quality framework SERVQUAL. This standard service-dimension model introduces eight quality dimensions: reliability, responsiveness, competence, access, courtesy, communication, understanding the customer and tangibles. This way of generating KPIs can also be seen as goal driven, as the dimensions of the predecessor to SERVQUAL express sub-goals of the high-level goal “customer satisfaction”.

Demonstration and evaluation of the solution

The method is demonstrated by using an illustrative example of how the method could be applied, based on a real-life case from eye health care. The method is evaluated by using an informed argument.

Concepts in focus

The concepts from the conceptual framework (see Section 2.2) that are in focus in paper 6 are marked as grey in figure 19.

The main research contribution of the paper

The main research contribution is the use of value models, goals, information and quality models to identify a complete set of KPIs, which can be used to measure goal and quality fulfillment of the services in an organisation.

The thesis author's contribution to the paper

The author contributed to all the parts of the paper. The thesis author's contribution to the paper corresponds to about 75 percent.

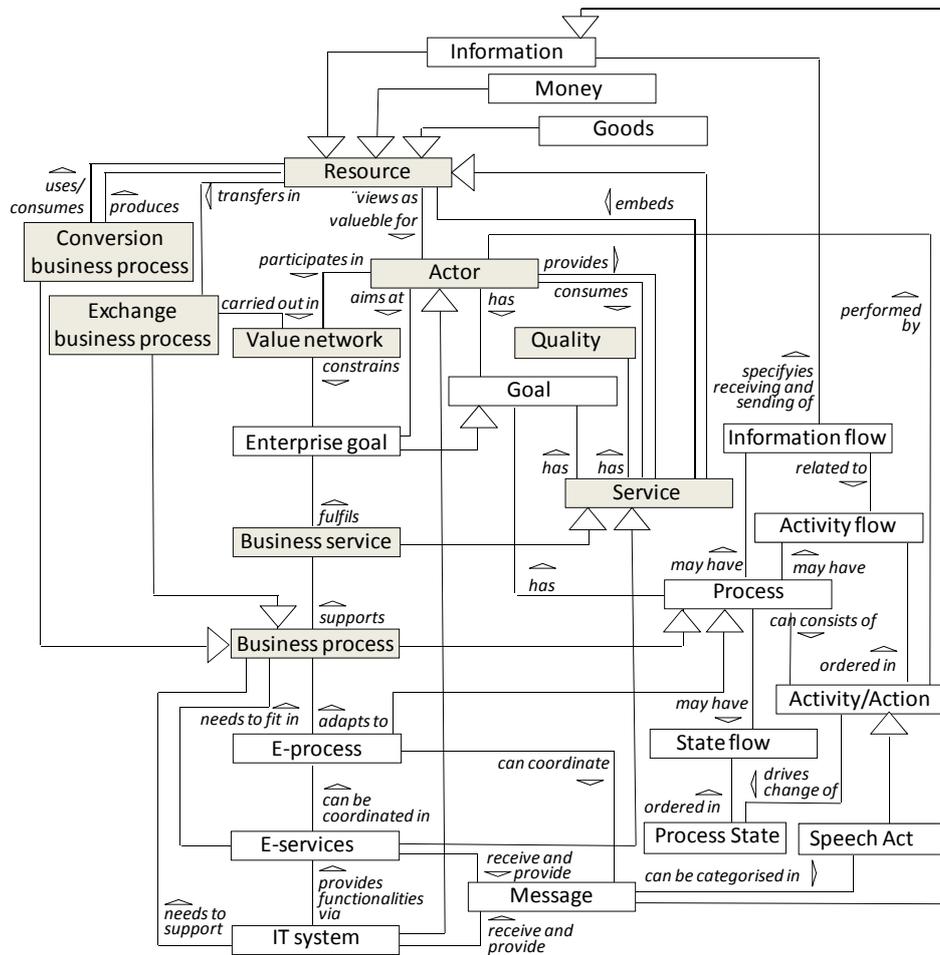


Figure 19. The concepts from the conceptual framework that are in focus in paper 6.

Paper 7

Henkel, M. and Perjons, E. (2011): E-Service Requirements from a Consumer-Process Perspective, In: Berry, D. and Franch X. (Eds.) *Requirements Engineering: Foundation for Software Quality, 17th International Working Conference, REFSQ 2011*, Essen, Germany, March 2011, Proceeding, LNCS 6606, Springer, pp. 121–135

The problem that the paper addresses

When designing e-services it is important that they fit smoothly into the business processes of business consumers. If the e-services do not fit there is a risk that the e-services designed by the e-service producers will not be used by the consumers as much as expected; the investment and effort to use the e-services might be too high for the consumers. Therefore, there is a need for an instrument (artefact) that supports the identifications of negative unintended effects on consumer processes, that is, the limitations that the e-services impose on the consumer processes.

The goal of the paper

The goal of the paper is to propose a method (the artefact) for identifying and analysing problems related to the e-services impact on the consumers' business processes. The method also supports identification of tentative solutions.

The solution described in the paper

The method consists of three steps: consumer process identification, consumer process analysis and solution summary.

The first step is *consumer process identification*. The aim of this step is the description of a consumer process in the form of its included activities, the order of activities, the structure and content of information used and produced in the activities, as well as needed roles for service interaction. The step includes both the direct interaction required to use the e-service, and the wider context of the service use, i.e. the activities that precede and follows the service interaction. To guide the process identification, an instrument is provided in the form of a set of guiding questions based on an existing four-aspect process framework. According to this framework, a process can be described in four aspects:

- Functional - Describes the set of activities within the process
- Behavioral - Describes how the activities are interlinked, i.e. their order of execution and how the activities are synchronised in time.
- Informational - Describes the needed information used and produced by the activities within the process.
- Organizational - Describes who is responsible for executing the activities. This is commonly described by using roles

The second step is consumer process analysis. The aim of this step is to find problems caused by the e-service, as well as tentative solutions to these problems. To guide this step we propose an instrument in the form of another set of guiding questions. These questions are based on a combination of the aforementioned four aspect-process framework, and another instrument

presented, four solution areas. The four solution areas are: changes in the service consumers' business processes, changes in the e-service, changes in the provider's business rules, and changes in the consumers' IT systems.

The third step is solution summary. The aim of this step is to summarise the problems and solutions found in the previous step according to the process aspects as well as the solution areas. To guide this summary, we provide an instrument in the form of a simple table structure, describing problems and possible solutions. The table structure also shows how a solution in the form of a consumer process change must be supported by a change in at least one of the solutions areas: the service provider's business rules, the service provider's e-service, or the service consumers' IT systems. Often, however, a solution in the real-life case presented in the paper, required changes in several of the solution areas.

All three steps above could be performed by a process/e-service analyst in collaboration with the consumers of the e-service. In the real-life case presented in this paper, we applied the guiding questions of step 1 and 2 in interviews with service consumers. However, the questions could also be used to guide workshops with several consumers present. The instrument in step 3 can be performed by a business analyst, in combination with other approaches to estimate the cost of performing the changes, and to prioritise the changes.

Demonstration and evaluation of the solution

The method is demonstrated by describing how the method was used in a real-life case at the Swedish Tax Agency. In order to identify and describe the consumers' tax declaration processes, we performed eleven semi-structured interviews with consumers of the tax agency's e-service. Out of the eleven interviews, six were performed with personnel at companies that worked as ombudsmen for tax declarations. The method was evaluated using informed argument.

Concepts in focus

The concepts from the conceptual framework (see Section 2.2) that are in focus in paper 7 are marked as grey in figure 20.

The main research contribution of the paper

The main research contribution is the approach of analysis in which a consumer process centric perspective is taken, based on an existing four-aspect process framework and the four solution areas. The four solution areas also provide the user of the method with tentative solutions.

HEALTHINF 2010, Third International Conference on Health Informatics, Valencia, Spain. INSTICC Press

- Juell-Skielse G. and Perjons E. (2009) Improving E-Government through Benefit Analysis and Value Modeling, In: Ahamed, S.I., Bertino, E., Chang, C. K., Getov, V., Liu L., Ming H., Subramanyan R. (eds): Proceedings of the 33rd Annual IEEE International Computer Software and Applications Conference, COMPSAC 2009, Seattle, Washington, USA, 20-24 July, IEEE Computer Society, pp. 332-339

5 Conclusion

This chapter starts with a discussion about the main contributions of this thesis. It continues with a discussion about how different target groups can make use of these contributions. The section ends with suggested future research.

5.1 The Main Contributions Revisited

The overall goal of this thesis is to propose methods for business process and e-process design and evaluation for achieving alignment between enterprise goals and IT systems. The methods are based on model-driven approaches, using enterprise and system models. The focus has been on business processes and e-processes which can function as adaptive mediators between the business and the IT systems.

It is important to emphasise that the usage of enterprise and system models in business and IT system development does not guarantee the creation of efficient, high-quality, flexible and innovative organisations. In fact, it might be the opposite. For example, a business process model may be designed to describe how people work in an organisation today. However, it might happen that this process model will also be the base for the design of a new IT system, although the business process model may not describe an efficient way of working given the new IT system. The result might be a new designed IT system supporting an outdated and ineffective way of working. Often, the introduction of a new IT system requires changes in both enterprise goals and business processes of an organisation in order to make use of the opportunities offered by IT, see discussion in Hoque (2002).

It is important, therefore, that methods for alignment provide organisations with designed business processes that support strategic and innovative options. Thus, some of the methods presented in this thesis utilise high-level enterprise modelling techniques, such as business and goal models, thereby enabling that organisations can manage knowledge about themselves as well as the environments in which they are embedded. Other methods make use of business processes modelling techniques that support alignment with goals and IT system, instead of focusing on the flow of activities. Such business processes modeling techniques can be the basis for designing more flexible IT systems given a more ad-hoc way of working. It is also important that the

methods support business processes that can manage flexibility, i.e. support changes in the business processes if the business or technology contexts require so. Therefore, some of the methods presented in this thesis make use of e-processes and e-process modelling. They can provide a flexible integration of new and existing IT systems and manage the changes in the business processes.

Four research questions have been driving the research presented in this thesis. The first research question was: “How to design business processes that support enterprise goals in a specific value network configuration of customers and vendors?”

To answer the first research question, a method for identifying innovative actions for collaboration among actors was presented. The method made use of high-level value and goal modelling techniques, which were adapted and combined. Value and goal models are useful instruments to identify new forms of collaborations, new ways of working, and new innovative actions. Therefore, the method could provide an organisation with strategic and innovative options before the business process design. The main contributions of the presented method are the adaption and combination of existing modelling techniques in order to identify innovative actions.

The second research question was: “How to design reusable business processes that support enterprise goals, i.e. how to design business processes that can be reused in different organisations?”

To answer the second research question a method for creating business process patterns for reusing best practices was presented. The method made use of a process modelling technique called state-flow technique. The state-flow technique provides a description of business processes where choices of actions do not need to be pre-defined; instead, the actions can be decided based on the situational context. The state-flow technique specifies the goal and the needed states of a business process which could steer the execution of process instances (cases). Therefore, the technique can manage both structured as well as more emergent and loosely-structured processes, which is common in more creative and knowledge-intensive work. The main contributions of the presented method are the definition of the business process pattern based on the state-flow technique, how the definition can be applied, and the application of the state-flow technique on a loosely-structured process, a lobbying process.

The third research question was: “How to design e-processes that support the integration of IT systems with business processes?”

To answer the third research question, two related methods are presented.

The first method is a method for designing e-processes that aims at ensuring that the designed e-processes are well-structured, understandable, and have a high quality. The method specifies different views and different types of e-processes: a view for the interaction with customers (via user interface e-processes); a view for the different IT applications (via application interface e-processes); and a view for the management of exception handling, and so on.

Thereby, a well-structured, understandable and flexible use of e-processes can be enabled. For example, changes in the interaction with an IT application can be managed via an application interface e-process interacting with the IT application. The main contributions of the presented method are the view guidelines and categories of e-processes, ensuring understandability and structure of the models, and the completeness guidelines, ensuring high quality models.

The second of the two methods describes a method for designing and applying e-processes and BPMS in a value network of health care organisations. The method describes the different steps carried out in a real-life business and IT development process: business analysis, systems analysis, security analysis, prototype development and project evaluation. This includes the design of health care processes, e-processes and business and IT architecture. The main contributions of the method are the presented steps of the method used in a real-life project and the suggested business and IT architecture.

The fourth research question was: “How to determine how well a business process is aligned with enterprise goals and IT systems?”

To answer the fourth research question, two different methods are presented.

The first method describes how indicators for measuring the performance of health care services can be created using the combination of value, goals and service quality models. Thereby, the alignment of goals and business services can be measured. The main research contribution is the use of value models, goals, information and quality models to identify a complete set of KPIs, which can be used to measure goal and quality fulfillment of the services in an organisation.

The second of the two methods is a method for identifying and analysing problems related to the unintended and negative impact of e-services on the consumers’ business processes. The main research contribution is the consumer process centric perspective taken in order to identify problems in the consumer process caused by the e-services of providers. The method is not only supporting the identification of problems, but it also supports identification of tentative solutions.

5.2 Implication for Different Target Groups

The main target groups of the thesis are business and system designers. Both groups will get practical knowledge on how to use enterprise and system models to support the alignment of business and IT systems in order to create efficient, high-quality, flexible and innovative organisations. There is a growing interest among practitioners for business-IT alignment, enterprise

architecture, and service-oriented solutions, which has increased the demand of methods to use in practice.

Another target group is students in information systems and business administration. Some of the methods presented in this thesis have been used in courses at the Department of Computer and Systems Sciences, Stockholm University. By introducing practical methods based on theories and modelling techniques, students can better understand the need for business and system modelling, and they can be provided with useful methods to apply in their upcoming business life.

A third target group is researchers in information systems and business administration. The methods described in this thesis will provide the researchers with solutions for different problems and situations, and may inspire them to design other solutions. Also the real life cases described in the papers can be used by other researchers for demonstration of their own solutions.

5.3 Future Research

The papers presented in this thesis and related research have shown that there exists a number of methods that aim to achieve business-IT alignment using enterprise and system models. For a practitioner it might be hard to find and choose a method that can solve a practical problem in an organisation. Therefore, one of the future research directions might be to apply several existing methods in a real life setting and evaluate them in order to compare and understand their respective strengths and weaknesses.

Another future research direction could be to create a method framework for the alignment of business and IT. Such a framework could consist of a number of methods on different levels for business-IT alignment. The framework could also provide method support for selecting and combining methods for business-IT alignment based on the type of problem to solve, see discussions in (Nilsson, 1999a).

A third research direction could be to design methods for evaluating the extent of alignment between enterprise goals and IT systems in organisations. Two such methods have been presented in this thesis, but more are needed. Business and system designer need to first analyse the need of alignment in order to understand which methods to use for achieving alignment.

A fourth research direction could be to investigate the use of state-flow technique in areas such as adaptive workflows, BPM for social software, and SOA. The use of the modelling technique in these areas has shown promising results so far, see Bider et al (2010) and Bider et al (2011).

References

- Aalst, W.M.P. van der, and Hofstede, A.H.M. ter (2005) YAWL: Yet Another Workflow Language, *Information Systems*, 30(4):245-275
- Aalst, W.M.P. van der., and Basten, T. (2002), Inheritance of Workflows: An approach to tackling problems related to change, *Theoretical Computer Science*, Vol 270, pp.125-203
- Aalst, W.M.P. van der., ter Hofstede, A., Kiepuszewski, B., and Barros, A. (2003), Workflow patterns, *Distributed and Parallel Databases*, 14 (3): 5-51
- Aalst, W.M.P. van der (1999), Flexible Workflow Management Systems: An Approach Based on Generic Process Models, *International Conference on Database and Expert Systems Applications*, LNCS Vol. 1677, pp. 186–195.
- Andersson, B., Bergholtz, M., Gregoire, B., Johannesson, P., Schmitt, M., and Zdravkovic, J. (2006) From Business to Process Models – A Changing Methodology, In: Latour, T. and Petit, M (eds) *Proceedings of Conference on Advanced Information Systems Engineering (CAiSE) Workshop and Doctorial Consortium*, Namur, Namur University Press
- Andersson, B., Bider, I. and, Perjons, E. (2005) Analyzing loosely structured business processes using a minimal software prototype. In: Khosrow-Pour, M. (ed.) *Managing Modern Organization with Information Technology, IRMA 2005 Proceedings, International Conference*, May 15–18, 2005, San Diego, California, USA. Information Resources Management Association, Idea Group Publishing
- Andersson, B., Bider, I. and, Perjons, E. (2005) Business process support as a basis for computerized knowledge management, In: Althoff K.-D., Andreas Dengel, Bergmann R., Nick M., Roth-Berghofer, T (eds) *Professional Knowledge Management*, Lecture Notes in Artificial Intelligence (LNAI), Vol. 3782. Springer Verlag, pp 542-554
- Andersson, B., Bider, I., Johannesson, P. and, Perjons, E. (2005) Towards a formal definition of goal-oriented business patterns, *Business Process Management Journal (BPMJ)*, 11(6), Emerald Group Publishing Ltd., UK
- Avison, D., Jones, J., Powell, P. and, Wilson, D. (2004). Using and Validating the Strategic Alignment Model, *Strategic Information Systems*, 13 (3): 223–246
- Baets, W.J. (1996). Some Empirical Evidence on IS Strategy. Alignment in banking, *Information & Management* 30(4): 155–177
- Bider, I. (2002) *State-oriented business process modeling: principles, theory and practice*, PhD thesis, Royal Institute of Technology, Stockholm
- Bider, I., Johannesson, P. and, Perjons, E. A. (2002) Goal-oriented patterns for business processes. In: Bider, I. & Johannesson, P. (eds.) *Proceedings of the HCI'02 Workshop on Goal-Oriented Business Process Modelling (GMBP'02)*, 2 September, London. CEUR-WS.org

- Bider, I. and Perjons, E. (2007) Effects from introduction of business process support systems and how they can be measured. In: Pernici, B. and Gulla, J.A.(eds.) *CAiSE'07 workshop proceedings*, Tapir Academic Press, Trondheim, Norway, pp. 369-377
- Bider, I., Johannesson, P. and, Perjons, E. (2010) In Search of the Holy Grail: Integrating social software with BPM. Experience report. *Enterprise, Business-Process and Information Systems Modeling*, LNBIP 50, Springer, pp. 1-13
- Bider, I., Johannesson, P., and, Perjons, E. (2011) A strategy for merging social software with business process support, In: zur Muehlen, Michael, Su, Jianwen (eds) *Business Process Management Workshops, International Workshops and Education Track*, BPM 2010, Hoboken, NJ, USA, September 13-15, Revised Selected Papers, Springer
- Bider I., and Perjons E. (2009) Evaluating Adequacy of Business Process Modeling Approaches, In: *Handbook of Research on Complex Dynamic Process Management: Techniques for Adaptability in Turbulent Environments*, IGI, pp. 79-102
- Bridgeland D.M. and Zahavi, R. (2009) *Business Modeling. A Practical Guide Realizing Business Value*, Morgan Kaufman/OMG Press
- Chan, Y. E, and Reich, B.H. (2007) IT alignment: what have we learned, *Journal of Information Technology*, Vol 22, Palgrave Macmillan Ltd, pp. 297-315
- Chan, Y.E., Sabherwal, R. and, Thatcher, J.B. (2006). Antecedents and Outcomes of Strategic IS Alignment: An empirical investigation, *IEEE Transactions on Engineering Management*, 51 (3), pp. 27-47
- Chan, Y.E. and Huff, S.L. (1993). Investigating Information Systems Strategic Alignment, *Proceedings of the Fourteenth International Conference on Information Systems*, Orlando, FL, pp 345-363
- Chan, Y.E., Huff, S.L., Barclay, D.W. and Copeland, D.G. (1997). Business Strategic Orientation, Information Systems Strategic Orientation, and Strategic Alignment, *Information Systems Research* 8(2): 125-150
- de Leede, J., Looise, J.C. and Alders, B. (2002). Innovation, Improvement and Operations: An exploration of the management of alignment, *International Journal of Technology Management* 23(4): 353-368
- Deiters W. and Gruhn V (1998). Process Management in Practice. Applying the FUNSOFT Net Approach to Large-Scale Processes. *Automated Software Engineering*, 5(1), 7-25
- Dietz, J. (1994) Business modeling for business redesign, *Proceedings of the 27th Hawaii International Conference on System Science*, IEEE Computer Society Press, Silver Spring, MD, 1994, pp. 723-732.
- Druker, P. F. (1988) The Coming of the New Organization, *Harvard Business Review*, (66:1), January-February 1988, pp. 45-53
- Edirisuriya A., and Zdrakovic, J. (2008) Goal support towards Business Process Modelling, In: *Proceedings of 5th International Conference on Innovation in Information Technology*, IEEE Xplore, Dubai
- FIPS (1993), *Integration definition for function modeling (IDEF0)*, Draft Federal Information Processing Standards, Publication 183 (Fips 183), available at: www.idef.com/downloads/pdf/idef0.pdf
- Goedvolk, H., van Schijndel, A., van Swede, V. and Tolido, R. (1997) Architecture, in D.B.B. Rijsenbrij (ed.) *The Design, Development and Deployment of ICT Systems*

- in the 21st Century: Integrated architecture framework (IAF), [Internet Article], http://home.hetnet.nl/_daanrijnsenbrij/progx/eng/contents.htm: Cap Gemini Ernst and Young.
- Goldkuhl G. (2004) Design Theories in Information Systems – A Need for Multigrounding, In: *Journal of Information Technology and Application (JITTA)*, 6(2):59-72
- Gordijn, J. and Akkermans, H. (2003) Value based requirement engineering: Exploring innovative e-commerce idea, *Requirement Engineering Journal*, 8 (2): 114-134
- Gordijn, J. and Tan, Y.-H.. A Design Methodology for Modeling Trustworthy Value Webs. *International Journal of Electronic Commerce*, 9(3):31-48, M.E. Sharpe, Armonk, NY, 2005
- Heinl, P., Horn, S., Jablonski, S., Neeb, J., Stein, K., and, Teschke, M. (1999), “A Comprehensive Approach to Flexibility in Workflow Management Systems”, *International Joint Conference on Work Activities Coordination and Collaboration*, ACM, pp. 79–88
- Henderson, J.C. and Venkatraman, N. (1993). Strategic Alignment: Leveraging information technology for transforming organizations, *IBM Systems Journal*
- Henkel, M. (2008) *Service Based Processes. Design for Business and Technology*, Doctorial Thesis in Computer and Systems Sciences, Royal Institute of Technology, DSV Report series No 08-010
- Henkel, M., Johannesson, P. and, Perjons, E.. (2007) Value and goal modelling in healthcare. In: *Proceedings of the Twelfth International Symposium on Health Information Management Research (iSHIMR 2007)*, 18–20 July 2007, Sheffield, UK, ISBN: 0-903522-40-3, pp. 43–50
- Henkel M., Johannesson P.,and, Perjons E. (2011) An Approach for E-service Design using Enterprise Models, *International Journal of Information System Modeling and Design (IJISMD)*, 2 (1)
- Henkel, M., Johannesson, P., Perjons, E.and Zdravkovic, J. (2007) Value and goal driven design of e-services. In: *The IEEE International Conference on e-Business Engineering (ICEBE'07)*, October 2007. IEEE Computer Society Press, 978-0-7695-3003-1, pp. 295–303
- Henkel, M. and Perjons, E. (2011): E-Service Requirements from a Consumer-Process Perspective, In: Berry, D. and Franch X. (Eds.) *Requirements Engineering: Foundation for Software Quality, 17th International Working Conference, REFSQ 2011*, Essen, Germany, March 2011, Proceeding, LNCS 6606, Springer, pp. 121–135
- Henkel, M., Perjons, E. A. and Zdravkovic, J. (2006) A value-based foundation for service modelling. In: *The European Conference on Web Services (ECOWS'06)*, December 2006, Zurich, Switzerland. IEEE Society Press, 0-7695-2737-X, pp. 129–137
- Henkel, M., Perjons, E. A. and Zdravkovic, J. (2007) Towards guidelines for the evolution of e-service environments, *International Journal of Public Information Systems*, 3, pp. 183–200.
- Hevner, A.R., March, S.T., and, Park, J. (2004), “Design Science in Information Systems Research”, *MIS Quarterly*, Vol. 28(1), pp. 75–105.
- Hoque, F. (2002) *The Alignment Effect. How to Get Real Business Value Out of Technology*, Prentice Hall

- Hruby, P. (2006). *Model-Driven Design of Software Applications with Business Patterns*. New York, Springer Verlag.
- Huckvale, T. and Ould, M. *Process Modelling- Who, What and How: Role Activity Diagramming*, Idea Group Publishing, 1998
- Iivry and Venable (2009) Action Research and Design Science Research Semingly Similar but Decisively Dissimilar, In: *17th European Conference on Information Systems (ECIS)*
- Irani, Z. (2002). Information Systems Evaluation: Navigating through the problem domain, *Information Management* 40(1): 11–24
- ITU-T (2002) *Specification and Description Language (SDL)*, Z-100, 08/2002, Telecommunication Standardization Sector of ITU, 2002
- Jablonski, S. (1995) *Workflow-Management-Systeme: Modellierung und Architektur*. Thomson Publishing
- Jayaweera, P. M. (2004) *A Unified Framework for e-Commerce Systems Development: Business Process Patterns Perspective*, PhD Thesis, Royal Institute of Technology, No 04-011
- Johannesson, P. and Perjons, E. (2001) Design principles for process modelling in enterprise application integration. *Information Systems*, Vol. 26, Elsevier Science Ltd, pp. 165–184
- Johannesson, P. and Perjons, E. (2000) Design principles for application integration. In: Wangler, B. & Bergman, L. (eds.) *Advanced Information Systems Engineering, 12th International Conference, CAiSE 2000*, Stockholm, Sweden, Proceedings. Springer Verlag, pp. 212-231
- Johannesson, P., Perjons, E. A., Wangler, B. And, Åhlfeldt, R.-M. (2005) Design solutions for interoperability using a process manager. In: Konstantas, D., Bourrières, J-P., Léonard, M. and Boudjlida, N. (eds) *Interoperability of Enterprise Software and Applications*, Springer Verlag, pp. 397–408
- Johannesson, P. and Perjons, E. A. (2010) Value driven KPI design in health care. In: Fred, A., Filipe, J. & Gamboa, H. (eds.) *Proceeding of HEALTHINF 2010, Third International Conference on Health Informatics*, Valencia, Spain. INSTICC Press
- Juell-Skielse G. and Perjons E. (2009) Improving E-Government through Benefit Analysis and Value Modeling, In: Ahamed, S.I., Bertino, E., Chang, C. K., Getov, V., Liu L., Ming H., Subramanyan R. (Eds.): *Proceedings of the 33rd Annual IEEE International Computer Software and Applications Conference, COMPSAC 2009*, Seattle, Washington, USA, 20-24 July, IEEE Computer Society, pp. 332-339
- Järvinen, P. (2007) Action Research is Similar to Design Science, *Quality & Quantity* 41:37-54, Springer
- Kearns, G.S. and Lederer, A.L. (2000). The Effect of Strategic Alignment on the use of IS-Based Resources for Competitive Advantage, *Journal of Strategic Information Systems* 9(4): 265–29
- Kleppe, A., Warmer, J., Bast, W. (2003), *MDA Explained*, Addison-Wesley
- Lamsweerde, A. van (2004) Goal-Oriented Requirements Engineering: A Roundtrip from Research to Practice. In: *Proceedings of the 12th IEEE International Requirements Engineering Conference (RE'04)*, IEEE Computer Society
- Lederer, A.L. and Mendelow, A.L. (1989). Coordination of Information Systems Plans with Business Plans, *Journal of Management Information Systems* 6(2): 5–19

- Lind, M. and Goldkuhl, G. (1997) Reconstruction of different business process}a theory and method driven analysis, *Proceedings of Conference on Language/Action Perspective '97*, Veldhoven
- Luftman, J.N., Lewis, P.R. and Oldach, S.H. (1993). Transforming the Enterprise: The Alignment of Business and Information Technology Strategies, *IBM Systems Journal* 32(1): 198–221
- Luftman, J., Kempaiah, R. and Nash, E. (2005). Key Issues for IT Executives 2005, *MIS Quarterly Executive* 5(2): 81–101
- Malone, T., Crowston, K., Lee, J., Pentland, B., Dellarocas, C., Wyner, G., Quimby, J., Osborn, C., Bernstein, A., Herman, G., Klein, M. and, O'Donnell, E. (1999), "Towards a handbook of organisational processes", *Management Science*, 45 (3): 425-43
- March, S. T., and Smith, G. (1995) Design and Natural Science Research on Information Technology, *Decision Support Systems*, 15 (4): 251-266
- Mayer, R.J., Painter, M.K., Menzel, C.P., Perakath, deWitte, B.P.S., and Blinn, T. (1995) Information integration for concurrent engineering (IICE) IDEF3 process description capture method report, Available at: <http://www.idef.com>
- McCarthy, W. E. (1982) The REA Accounting Model: A Generalized Framework for Accounting Systems in Shared Data Environment, *The Accounting Review*
- McLean, E.R. and Soden, J.V. (1977). *Strategic Planning for MIS*, New York: Wiley
- Nilsson, A.G. (1999a) The Business Developer's Toolbox. Chains and Aliiances between Established Methods, In: Nilsson, A., Tolis, C., and Nellborn (1999) Perspectives on Business Modelling. Understanding and Chaning Organisations, Springer
- Nilsson, A. G., Tolis, C., and Nellborn (1999) Perspectives on Business Modelling. Understanding and Chaning Organisations, Springer
- Nilsson, B. E. (1999b) On Why to Model What and How: Concepts and Architecture for Change, In: Nilsson, A. G., Tolis, C., and Nellborn (1999) Perspectives on Business Modelling. Understanding and Chaning Organisations, Springer
- Nurcan, S., Etien, A., Kaabi, R., Zoukar, I., and Rolland, C. (2005), "A Strategy Driven Business Process Modelling Approach", *The Business Process Management Journal*, Vol. 11(6), Emerald Publishing, pp. 628–649
- Nurcan, S., Etien, A., Kaabi, I. Zoukar, and Rolland, C. (2005), A Strategy driven business modelling approach, In: *Business Process Management Journal*, Vol. 11(6), Emerald Publishing
- OMG (2010a) *OMG Unified Modeling Language™ (OMG UML), Superstructure*, Version 2.3, Object Management Group, available at (2011-04-19): <http://www.omg.org/spec/UML/2.3/Superstructure> , maj 2010
- OMG (2010b) *Business Motivation Model*, Version 1.1, Object Management Group, available at (2011-04-19): <http://www.omg.org/spec/BMM/1.1/>, maj 2010
- OMG (2011) *Business Process Model and Notation (BPMN)*, Version 2.0, Object Management Group, available at (2011-04-19): <http://www.omg.org/spec/BPMN/2.0>, jan2011
- .Orlikowski, W. J. (2000) Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations, *Organization Science*, 11 (4): 404-428

- Orlikowski, W. J. and Barley, S. R. (2001) Technology and Institutions: What Can Research on Information Technology and Research on Organizations Learn From Each Other?, *MIS Quarterly*, 25 (2): 145-165.
- Osterwalder, A. (2004) *The Business Model Ontology*, PhD thesis, HEC Lausanne, Available at <http://www.hec.unil.ch/aosterwa/>, accessed 2008-01-05
- Papazoglou, M. P. and Yang, J. (2002). Design Methodology for Web Services and Business Processes. In: *Proceedings of the Third International Workshop on Technologies for E-Services (TES 2002)*, Hong Kong, China (LNCS 2444, pp. 54-64). New York: Springer Verlag
- Parasuraman, A., Zeithaml, V. A., and Berry, L. L. (1988). SERVQUAL: a multiple-item scale for measuring consumer perception of service quality. *Journal of Retailing*, 64(1), 12-40
- Piccinelli, G., Emmerich, W., Zirpins, C., and Schütt, K. (2002). Web Service Interfaces for Inter-Organisational Business Processes – An Infrastructure for Automated Reconciliation. In: *Proceedings of the 6th International Enterprise Distributed Object Computing Conference (EDOC 2002)*, Lausanne, Switzerland (pp. 285-292). Washington, DC: IEEE Computer Society
- Peffer, K., Tuunanen, T., Rothenberger, M.A., and Chatterjee, S. (2007) A Design Science Research Methodology for Information Systems Research, *Journal of Management Information Systems*, 24(3): 45-78
- Perjons, E. and Johannesson, P. (2011) A Value and Model Driven Method for Patient Oriented KPI Design in Health Care, In: Fred, A., Filipe, J., Gamboa, H. (Eds.) *Biomedical Engineering Systems and Technologies, Third International Joint Conference, BIOSTEC 2010*, Valencia, Spain, January 20-23, 2010, Revised Selected Papers, Communications in Computer and Information Science, Vol. 127, Springer, pp.123-137
- Perjons, E., Wangler, B. and Åhlfeldt, R. (2006), Efficient and Secure Process and IT Integration in Healthcare, In: Carlsson et al (eds.), *Knowledge in Organisations I*, Skövde University Studies in Informatics, ISSN 1653-2325, pp.11-20
- Perjons, E., Bider, I. and Andersson, B. (2007) Building and exploiting a business process model for lobbying: Experience report. *Communications of the IIMA (CIIMA)*, Vol. 7, No. 3, The International Information Management Association, pp. 1-14
- Perjons, E., Wangler, B. Wäyrynen, J. And Åhlfeldt, R.-M. (2005) Introducing a process manager in healthcare: An experience report, *Health Informatics Journal*, Vol. 11, No. 1, pp. 45-61
- Pijpers, V. and Gordijn, J. (2007) Bridging Business Value Models and Process Models in Aviation Value Webs via Possession Rights, In: *Proceedings of the 40th Annual Hawaii International Conference on System Science (HICSS)*
- Rapoport, R. N. (1970) Three dilemmas in action research, *Human Relations*, 23 (6): 499-513
- Prahalad, C. K., and Krishnan, M. S. (2008). *The New Age of Innovation. Driving Cocreated Value Through Global Networks*. New York: McGraw-Hill.
- Reich, B.H. and Benbasat, I. (2000). Factors that Influence the Social Dimension of Alignment between Business and Information Technology Objectives, *MIS Quarterly* 24(1): 81-113
- Singh, S., N. and Woo C. (2009) Investigating business-IT alignment through multidisciplinary goal concepts, *Requirements Engineering* 14: 177-207

- Searle, J.R. (1969) *Speech Acts- An Essay in the Philosophy of Language*, Cambridge University Press, Cambridge, MA, 1969
- Soffer, P. and Wand, Y. (2004) Goal-driven Analysis of Process Model Validity, *Proceedings of Conference on Advanced Information Systems Engineering (CAiSE)*, LNCS 3084, Springer
- Terai, K., Izumi, N., and Yamaguchi, T. (2003), “Coordinating Web Services Based on Business Models”, *International Conference on Electronic Commerce*, Pittsburgh, USA, September 30 - October 03, ACM Press, pp. 473–478
- Venable, P. (2006) The Role of Theory and Theorising in Design Science Research, *DERIST 2006*, Feb 24-25 2006, Claremont
- Venable, J. R. and Travis, J. (1999). Using a Group Support System for the Distributed Application of Soft Systems Methodology, in Hope, B. and Yoong, P. (eds.) *Proceedings of the 10th Australasian Conference on Information Systems*, Wellington, New Zealand, pp. 1105-17
- Vitale, M.R., Ives, B. and Beath, C.M. (1986). Linking information technology and corporate strategy: An organizational view, *Proceedings of the Seventh International Conference on Information Systems*, San Diego, USA. 265–276
- Wangler, B., Perjons, E. A. & Åhlfeldt, R.-M (2003) Process oriented information systems architectures in healthcare. *Health Informatics Journal*, Vol. 9, No. 4, pp. 253–265
- Winograd, T. and Flores, F. (1986) *Understanding Computers and Cognition: A New Foundation for Design*, Ablex, Norwood, NJ
- Yu, E.S.K., Du Bois, P., Dubois, E., and Mylopoulos, J. (1995), “From Organization Models to System Requirements: A 'Cooperating Agents' Approach”, In *Proceedings of the International Conference on Cooperative Information Systems (CoopIS'95)*, Vienna, Austria, pp. 194–204
- Yu, E. (1995) *Modeling Strategic relationships for process engineering*, Dep. Of Computer Science, University of Toronto

Appendix 1.

Evaluation of a variant of the artefact presented in Paper 1

This appendix described the result from an evaluation of a method for designing innovative e-services for collaboration among actors in a health care value network. The method is using value and goal models to drive the identification of the e-services. The method and the evaluation are presented in (Henkel et al, 2011). This appendix is an excerpt of the Henkel et al (2011).

The method evaluated in this appendix is a variant of the method presented in Paper 1, i.e. (Henkel et al, 2008). Both variants are combining value and goal models. However, the variant evaluated in Appendix 1 are used for identifying e-services while the variant presented in Paper 1 are used for identifying actions. However, the evaluation presented in this appendix has relevance for Paper 1 since the first method steps are the same in the both variants of the method.

The evaluation of the method for identifying e-services was carried out using semi-structured interviews with the CEO of a hospital specialised in eye health care, and two system developers. The CEO was the project leader of the REMS project, The two system developers have been gathering the requirements on the e-services, as well as carrying out the design and implementation of the e-services in the REMS project. Both the CEO and the two system developers have been, together with health care providers, participating in modelling sessions where the method has been applied.

The CEO and the two system developers were chosen for the evaluation since they have experiences with other requirement engineering methods for identify e-services.

Three objectives of the artefacts have been used as evaluation criteria:

- Efficiency – the method should use minimal resources
- Expressivness – the method should identify new and innovative actions
- Comprehensible – the method should be understandable for domain experts

The result of the evaluation is described below by first presenting the value model creation part of the approach and then the goal model creation.

The evaluation of the value model creation showed several benefits and no direct drawbacks. According to the interviewees, the value model gave an easily comprehensible overview of the transfers of resources in the network of health care actors as a whole. The classification of economic resources into goods, services, money and information facilitates efficient identification and understanding of the transfers. Beneficial was also the possibility to express “soft” aspects such as the desire for safety and knowledge in the form of intended effects. This fits well with the health care domain where such intended effects are essential.

The evaluation of the goal model creation part of the approach, showed both benefits and drawbacks. A benefit that was highlighted was that the approach provided a clear, comprehensible, link between the values, goals and e-services, i.e. the approach showed how e-services support goals and values. Another benefit was that the expressiveness of the goal model supported prioritisation among e-services, when choosing e-services to implement among a number of candidate services. A third benefit was the use of a set of pre-generated top-level goals which was viewed as an efficient and inspiring means for the modelling group in order to identify sub-goals and e-services. However, the use of pre-generated top-level goals was also mentioned as a potential efficiency drawback, as they could hinder thinking “outside of the box”. Another efficiency drawback that was mentioned was that there is no way to be sure that the goal models are complete, in the sense that it covers all possible ways to improve the resource exchanges in the value model. However, the use of both intended effect guideline and resource enhancer guideline seems to support the completeness requirement on top-level goals. A third drawback was that the approach did not express concrete means for the prioritisation of the e-services, by relating benefits or revenues to each goal in the goal model, and relating costs for development and maintenance to the e-services.

In Henkel et al (2011), the goal fulfilment of the implemented e-services was also evaluated by interviewing users, i.e. the health care providers, of the e-services.