Control Patterns in a Healthcare Network

x, y, z,
--
{x,y,z}@u.r

ABSTRACT

In this paper we present *control patterns* for the analysis and design of control mechanisms in a network organization. A control pattern is a description of a generic and reusable control mechanism that solves a specific control problem, to be selected on the basis of the context. To represent the context and solution, we analyze a network organization as a set of actors who transfer objects of economic value. The usefulness and adequacy of the control patterns is demonstrated by a case study of the governance and control mechanisms of the Dutch public health insurance network for exceptional medical expenses (AWBZ).

Keywords

governance and control, community-based (we-centric) services, business opportunities, E-health..

1. INTRODUCTION

In the Netherlands, the healthcare sector is making a transition from a supply-driven structure, in which healthcare providers (e.g. hospitals) decide what healthcare services are delivered, towards a more demand-driven structure, in which the patient can select healthcare services (e.g. treatment, physiotherapy, domestic care) from different providers. Such a market for healthcare requires that patients know enough about the available services and providers to make an informed choice. Currently however, patients perceive the healthcare offer as fragmented, and not fitted to their needs [19]. Little information is available about the services offered by different care providers, and about their quality of those services.

This research is carried out as part of the FrUX project[8]. The project develops a *dynamic interactive social chart for dementia care* (DEM-DISC): an interactive website that will provide an overview of the healthcare services available in a region, and provide personalized advice about possible combinations of healthcare services, so called service bundles. The Social Chart is designed for the relatives and informal caregivers of patients with Alzheimer's disease (dementia). One of the aims is to develop a generic method for generating bundles of services, tailored to the specific needs of a user [2]

We are interested in the governance and control aspects of a complex information service like the Social Chart. Before starting a software requirements engineering process, it is crucial to get an understanding of the business model that underlies the healthcare network. The healthcare sector is highly regulated. Moreover, the regulations that govern the healthcare system are subject to change. Because changes are the outcome of a political process with many stakeholders, the way they develop can remain unclear. Moreover, when the healthcare regulations change, the business opportunities for the Social Chart may well change too. For these reasons it is important to develop a *generic method* for analyzing and developing governance and control regulations, and for discovering corresponding business opportunities. Important elements of such a method are (i) a representation language and graphical modeling tool for the analysis and redesign of control procedures, based on accounting principles, (ii) a set of general guidelines to assist in analyzing and redesigning control procedures, and (iii) a library of generic control mechanisms, that have been validated and can serve as 'best practices'. Regarding (i), the *e3-control* methodology provides a representation language and graphical modeling tool [13]. The *e3-control* methodology is based on the *e3-value* ontology, which analyzes network organizations in terms of the transfer of *economic value* between participants[13]. The resulting model is called a *value network*.

In this paper we extend this work, and present a set of *control patterns*. A control pattern is a description of a generic and re-usable control mechanism that solves a control problem, to be selected on the basis of the context of application. A control problem is a identifiable risk for opportunistic action by one of the other network participants. So control patterns combine guidelines (ii), with best practices (iii). Control patterns are inspired by the design patterns approach, which was proposed in architecture [1] and is now very successful in software engineering. More recently, it has also been applied in the business domain, to administrative processes [20], organizational structures [7] business process reengineering [4]

The usefulness and adequacy of control patterns is validated on a case study of the value network for the Dutch public health insurance system AWBZ (Exceptional Medical Expenses Act). The governance and control aspects of this system are interesting, because it is funded by taxes, and lacks direct feedback on the quality of services. The system is undergoing changes, one of which is the introduction of a personal budget. This facilitates the development of a kind of market for care providers. Although an analysis approach based on economic value works well in commercial settings, one could question its suitability for the public sector. We are therefore especially interested in the applicability of control patterns in a highly regulated value network, which involves many public-private partnerships [16].

The paper is structured as follows. In section 2 we present the definitions of control patterns, explaining the underlying control theory. In section 3 we apply the control patterns to the case study, in a way reverse engineering the way in which the network may have developed.

2. CONTROL PATTERNS

A sustainable network organization needs mechanisms to govern and control the interaction among network participants. In most cases, interaction is encoded in contractual arrangements, and implemented through procedures and regulations. But regulations can be violated. In the context of control theory, a network organization is therefore considered to be either in an *ideal situation*, in which no errors, opportunistic behavior or fraud occurs, or in a *sub-ideal situation*, in which errors, opportunistic behavior and fraud do occur [13]. Sub-ideal situations can be prevented, detected or corrected by means of a control mechanism. In the accounting literature control mechanisms are typically analyzed from an operational or procedural perspective, with process models and flow charts [24][22]. In a network organization, the ideal situation is often determined by the business model of the network. Therefore, we need a value-based perspective to analyze the reasons for implementing a control mechanism.

2.1 Business Modelling

There are several methodologies that address design issues of business models of network organizations, like BMO[27], value webs[28], and *e3-value*[13]. Of these, *e3-value* is the only one with a formal semantics, and a specific focus on value transfers between enterprises. The method is ontologically well-founded, and is supported by graphical modeling tools. We therefore apply the *e3-value* ontology [13] for the description of so called *ideal models*, which express organizations that behave in compliance with the procedures and regulations. *Sub-ideal models* are expressed using *e3-control*, a modification of the *e3-value* ontology, used to describe opportunistic behavior of actors [13].

2.1.1 Ideal Value Models

An *e3-value model* provides a conceptual model of the value transfers in a business network, encoded in the *e3-value* ontology [13]. The *e3-value* constructs have a graphical notation. Figure 1(a) shows an example of a buyer who obtains goods from a seller and offers a payment in return. According to the law, the seller is obliged to pay value-added tax (VAT). This can be conceptualized by the following *e3-value* constructs (in bold). **Actors**, such as the buyer, seller, and the tax office are economically independent entities. Actors transfer **value objects** (payment, goods, VAT) by means of **value transfers**. For each value object, some actor should be willing to pay, which is shown by a **value interface**. A value interface models the *principle of economic reciprocity*: actors are only willing to transfer a value object, in return for some other value object. So only if you pay, can you obtain the goods and vice versa. A value interface consists of **value ports**, to represent that value objects are offered to and requested from the actor's environment. Actors may have a **consumer need**, which, following a **path of dependencies** will result in the transfer of value objects. Transfers are either dependent on other transfers, or lead to a **boundary element**. The *e3-value* methodology also allows the designer to assign monetary values to value transfers in a spreadsheet and calculate profitability of actors in a network.

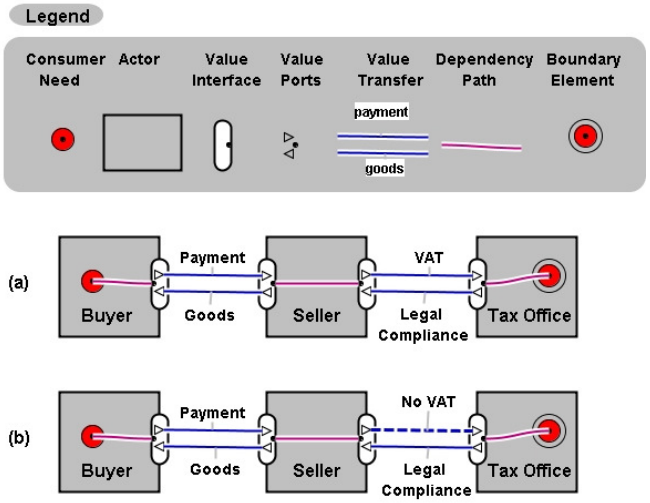

Figure 1. Example of an *e3-value* model of a purchase

2.1.2 Sub-Ideal Value Models

In *e3-value* it is assumed that actors behave in an ideal way, meaning that all value transfers occur as prescribed. This implies, among other things, that actors respect the principle of economic reciprocity. But in reality, actors may commit fraud or make unintentional errors, e.g. actors will not pay, or not obtain the right goods. In *e3-control*, such sub-ideal value transfers are graphically represented by dashed arrows [13]. For example, Figure 1(b) models the sub-ideal situation in which the seller does not pay VAT tax.

2.1.3 Process Models

Value models consider the transfer of value objects, like money, a good, or a service. This is effectively the transfer of ownership rights[15]. But such transfer requires *operational* activities to be performed, by multiple actors, which can only be shown using a process model. Moreover, in value models the temporal order in which objects are transferred is abstracted over: it only represents *that* objects are transferred, but not in which *order*. The order in which activities take place, forms a crucial part of many control mechanisms. So in addition to value models we need process models to capture control aspects. We represent process aspects of control problems and their solutions by UML-activity diagrams [23].

2.1.4 Information Models

Evidence documents form an important part of the administrative control mechanisms studied in this paper. Think for example of receipts, or tickets. Nowadays, documents are often certified files in a distributed information system, of which the paper document is only a trace. For an analysis of the structure and content of documents, UML class diagrams are a suitable representation format. Other issues are related to the management of information. Which party should store the documents? How is privacy, accuracy and reliability of the data preserved?. For such issues, see Ch8 of Ronmey and Steinbart[22]. In this paper, we focus only on the procedural role of documents in control mechanisms.

2.2 Control Theory

Control problems are typically identified by an analysis of risk indicators and threats discovered in an audit process. A control mechanism prescribes how to organize business processes in order to prevent, detect or reduce the risks posed by a control problem. Internal control theory is concerned with organizational measures inside an organization [24]. But in inter-organizational settings, risks related to the behavior of partners in a network, are mostly dealt with by contractual arrangements. Therefore, it is difficult to apply internal control guidelines directly. We studied work of Chen [6] on *detective controls*, and Bons et al.[5] on inter-organizational trade procedures, which also involves *preventative control*. Based on this background, we identify a *vocabulary* of terms (in **bold**), to be used in the definition of control patterns.

A network organization can be interpreted as a number of binary value transactions between actors. When parties in a network do not have an existing business relationship, lack of trust is likely. Trust has been defined as "*The willingness of a party to be vulnerable to the actions of another party based on the expectation that the other party will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party*"[18], p 712. Without trust, a party that invests in a transaction, is uncertain whether the other party will perform its part of the deal, or behave opportunistically. This is called 'ex-post' opportunism [29]. The purpose of inter-organizational controls is to reduce the uncertainty, and provide enough guarantees for parties to engage in a transaction.

In our terminology, the risks are assessed from the point of view of the **primary actor**, who does not trust the **counter actor,** and must therefore design control mechanisms against sub-ideal behavior of the counter actor. From a value perspective, we can say that the primary actor transfers a value object, called **primary object**, to the counter actor, and the counter actor returns a value object called **counter object**. From a process perspective, such a transaction is modeled by two operational activities: the primary actor performs a **primary activity**, and the counter actor executes a **counter activity**, each resulting in the corresponding value transfers. Figure 2 shows a value model of such a transaction on the left, and the corresponding process model on the right. The order in which the primary activity and counter activity occur is not specified. This is indicated by the UML notation for parallel execution (thick horizontal bar).

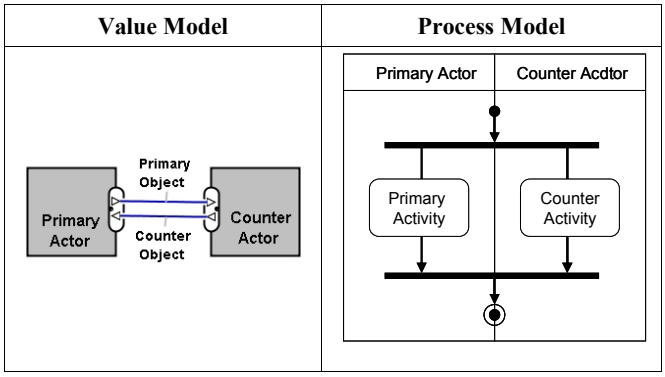

Figure 2. Transaction Scenario

Detective control [6] is concerned with **verification**: comparing the results of an **operational activity** with some claim about its legitimacy, quality or quantity. The claim is represented by a **document to-be-verified**. One or more **supporting documents** represent evidence about the operational activity. The result of a verification is usually a decision to perform some action or not, or else an evidence document stating the decision. One way of obtaining evidence about an activity, is by a **witness** activity When parties sign a contract, evidence of commitments is generated by **confirm.** For the transfer of a value object, we use activities **request** and **provide.** When the value object is a fee, we use the activity **pay**.

2.3 Pattern Definition

Traditionally, a design pattern has four essential elements: *pattern name, problem, solution, and consequences* [12] p3. We have separated the description of the context in which a pattern is to be applied, from the problem which motivates the selection of a pattern [7]. The context describes the business network with the actors, their relationships, like trust, and the activities to be controlled. The problem specifies a risk to be detected or prevented by the solution of the pattern. The solution describes the value network and the corresponding process model, after implementing the control mechanism encoded in the pattern.

Definition 2.1 (control pattern) A *control pattern* is a description of a generic and re-usable control mechanism for a recurring control problem, selected on the basis of the context.

name: a descriptive name of the pattern, used to select patterns from a pattern library.

context: a description of the business network to be controlled, modeled from an ideal perspective, meaning that no one behaves opportunistically. The context is represented by a value model (section 2.1.1), and if needed for understanding the context, also by a process model.

problem: a statement of risks for opportunistic behavior. A control problem exists if there is some deviation of the prescribed transfers of economic value. So we model the problem by a sub-ideal value model (see section 2.1.2), using sub-ideal value transfers. Again, if needed, we also use a process model.

solution: description of a control mechanism, to detect, prevent or correct the control problem. The solution is described by both process models and value models.

Table 1 contains an overview of our library of reusable control patterns. They were elicited using the *PattCaR method* [25]. Based on literature and case studies, we identified potential patterns. These were modeled with e3-control and activity diagrams, and compared using a commonality-variability analysis. The resulting patterns are validated in case studies, one of which is presented here.

In addition, there are *organizational design patterns* (Table 2). We use **delegation** of an activity to some external actor. We assume that the actor to whom the activity is delegated, is trusted by the primary actor, so no additional control measures are required. **Decomposition** of activities is used for efficiency.

Table 1. Library of Control Patterns

Name	Control Problem	Solution
Pre-execution Verification	primary actor is not certain whether counter actor will execute the counter activity as agreed	verify counter activity, before executing primary activity
Execution Confirmation	counter actor may deny that primary activity was executed as agreed, and refuse to execute counter activity, or require compensation	require confirmation from counter actor that primary activity was executed as agreed
Proper Contracting	counter actor may deny to have made a commitment to primary actor	require confirmation of commitment from counter actor
Partner Selection	counter actor may not be a reliable partner to make commitments with	before making ay commitments, verify credentials of counter actor
Certification	counter actor may not be reliable to perform counter activities	require verification of past behavior of counter actor

Table 2 Organizational Design patterns

Name	Objective	Solution
Delegation	activity can not be effectively or efficiently done	delegate activity to a specialized trusted external actor
Decom-position	activity can not be effectively or efficiently done	decompose activity in parts, which can be more effectively or efficiently carried out

3. VALIDATION IN HEALTHCARE

In this section, we show how the control patterns can be applied to the AWBZ case. In particular, we focus on the fact that the AWBZ case exemplifies a *highly regulated* value network that involves many *private-public partnerships*.

The case study is presented in two parts. The first part tries to explain how the current governance and control mechanisms may have developed, by means of the patterns. In the second part, we study the control problems that arise from the introduction of a personal budget, and show how the Social Chart could provide a solution. We discuss three possible future scenarios for exploiting an information service like the Social Chart.

The data for the case study was collected by semi-structured interviews with five experts from different healthcare organizations. The resulting *e3-control* models were verified by the experts. In addition, we used publicly available policy documents, like [11], and government websites about regulations.

3.1 Reverse Engineering the AWBZ

In the Netherlands, the AWBZ[1] deals with long-term and chronic diseases, such as protracted illness, invalidity, learning disability, mental disorders and geriatric diseases. Because this kind of care is too expensive to insure in a regular way, the system is arranged as *public* healthcare. A patient only pays a small part of the costs; the largest part of the costs is reimbursed to the care provider by a government fund, collected from taxes.

Suppose we have a hypothetical healthcare system (Figure 3). There are two parties: the patient and the care provider, for example a general practitioner. The patient receives care in return for fees. The corresponding process model is relatively simple: the patient pays only after receiving the care, according to the pre-execution pattern, applied from the perspective of the patient (Table 3). So there is direct quality feedback. The task of paying the fees may be delegated to a trusted party, for example the family of the patient.

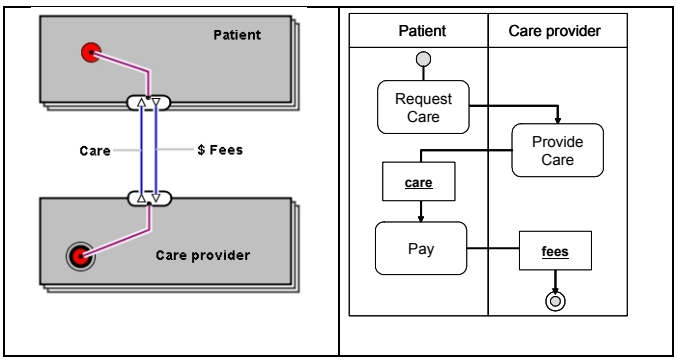

Figure 3. Hypothetical Care Transaction

Table 3 Applying Pre-execution Verification

Name	Pre-execution Verification
Context	Patient (primary actor) receives care (counter object) from care provider (counter actor) in return for fees (primary object).
Problem	Patient is not certain if the care provider will provide care, as agreed
Solution	Patient must verify that care is provided, before paying the fees.

Note that because of differences in expertise and status, the patient, or the family of the patient, are often not in a position to verify the quality of the care. Patients tend to trust care providers. Generally, care providers do not only provide care to get paid, but also to help patients. So, applying accounting models and professional distrust seems inappropriate for many care situations. Nevertheless, it may help to understand the governance and control of the healthcare system. This caveat applies throughout the rest of the case

[1] Algemene Wet Bijzondere Ziektekosten (Exceptional Medical Expenses Act)

In this hypothetical situation, there is a problem. Not all citizens fall ill, but those who do, are faced with very high costs. For long-term and chronic diseases, these costs can not even be carried by individual health insurance policies. Some kind of solidarity is needed between healthy citizens and chronic patients, managed by the government[10]. Such an exceptional healthcare system is shown in Figure 4. The solidarity is shown by the fact that value transfers may be summed over a `stack' of actors, for a specific time period.

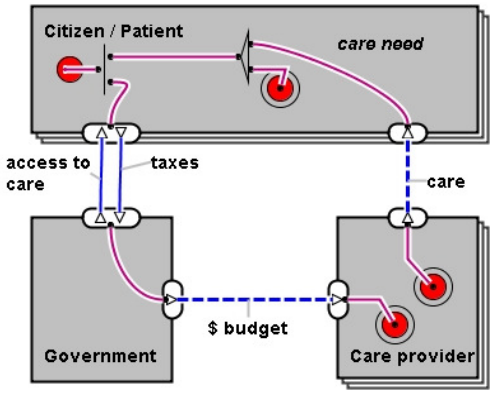

Figure 4. Solidarity

There are essentially two value transfers. The first one, on the left, is concerned with access to healthcare. Citizens pay taxes, in return for the government funding care providers. When citizens do fall ill and become patients, depicted on the right, they can use the infrastructure. These possibilities are linked by a choice-fork (triangle). The model is sustainable, as long as the income from the taxes of citizens is sufficient to cover the average costs of providing care services (Σ *taxes* $\geq \Sigma$ *budget*).

This is not a valid *e3-value* model. First, the value transfer 'care', is a single value transfer. The reciprocal value transfer is made indirectly, through taxes. For this reason, there is no direct feedback about the quality of the care provided, to the actor who decides about funding. Such indirect dependencies are typical for the public sector. Second, there is no reciprocal evidence, that the care requested by a patient, is actually needed. In a regular insurance system, this would correspond to the verification that a claim is eligible according to the insurance policy and conditions. Third, for the value transfer 'budget' no reciprocal evidence is required to ensure accountability of the care provider. Moreover, in this model, funding of the care provider is not linked to the number of care services offered. Typically, a yearly budget is set

We first focus on the control problems of the care provider.

Control Problem 1a. A care provider receives a budget, without being held accountable for the money. Control theory dictates, that every activity should be verified, with evidence of its execution [6][24]. Here, that means that the two dependency paths should be linked. On the basis of the control problem, that the care provider may receive a budget (primary object), that stands in no relation to the care actually provided (counter object), we therefore select the pre-execution verification pattern (Table 4).

Table 4 Applying Pre-execution Verification to Problem 1a

Name	Pre-execution Verification
Context	Government (primary actor) pays budget (primary object), so that the care provider (counter actor) may provide care to patients (counter object).
Problem	Government is not certain if the budget is in proportion to the care provided to patients
Solution	Government must verify what care is provided, before paying the budget. The control activities 'witness' and 'verify' are added, as well as 'supporting document', namely the evidence.

Control Problem 1b. All the costs of the care provider are reimbursed by the government. Therefore, there is no incentive for care providers to try and work more efficiently. Such an 'open-ended' system is one of the general reasons behind the increase in healthcare spending. Currently, there is much interest in budgeting schemes to reduce this problem, for example by output budgeting. We interpret budget agreements between government and care provider as a kind of mutual commitment, and select the Proper Contracting pattern (Table 5). Before committing to a certain budget, the government needs a commitment from the care provider that they can and will provide care for such a budget. In some cases the budget is calculated by standardized Diagnosis-Treatment Combinations .

Table 5 Applying Proper Contracting to Problem 1b

Name	Proper Contracting
Context	Government (primary actor) pays budget (primary object), so that the care provider (counter actor) may provide care to patients (counter object).
Problem	Care provider may claim to have no commitment to provide care for a given budget, and hence refuse to continue to provide care.
Solution	Government only commits to a specific budget, if care provider makes a commitment to provide the agreed care for that budget. Efficiency gains can be reinvested by the care provider.

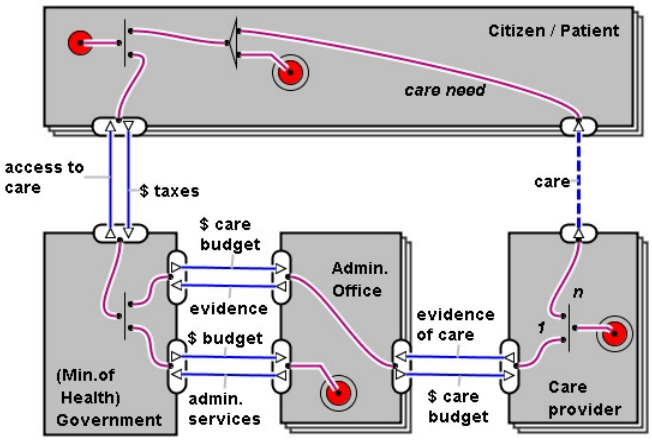

Figure 5. Output Budgeting and evidence (value model)

The result of applying these two patterns is shown in Figure 5 (value network) and 6 (process model). The task of controlling the budgets of care providers, and verifying the evidence, is delegated to an independent local agency, called Administration Office. For its administration task, the Administration Office receives a yearly budget from the government. This budget is fixed; it does not depend on the amount of care delivered by the care providers. By contrast, the budget of the care provider (1) depends on the number of care services actually delivered (*n)*

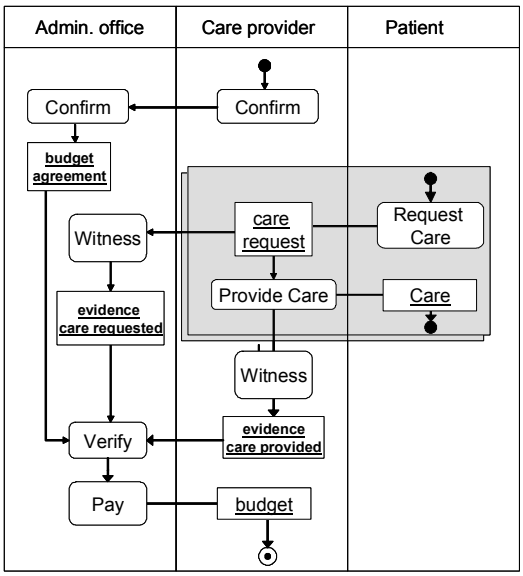

Figure 6. Output budgeting and evidence (process model)

Control Problem 2a. Now we concentrate on the patient. Although every citizen is entitled to healthcare when needed, access should be restricted to patients whose care is (medically) necessary. Again we frame this problem as an instance of pre-execution verification. The government or some government agency, must verify on the basis of evidence, like medical tests or a diagnosis from a physician, to which kinds of exceptional care the patient is entitled to.

Control Problem 2b. Initially, before March 2003, needs assessment was combined with the task of allocating actual care. Both were carried out by Regional Indication Centers (RIO). However, in some cases the needs assessments turned out to be inadequate: patients from different regions were given different products for the same diagnosis.

These problems can be addressed by two applications of pre-execution verification, combined with the general accounting principle of *standardization*[24]. In the AWBZ, care is categorized in standardized *functions*: domestic care, personal care, nursing, supportive assistance, activating assistance, treatment and institutional care. For each function, there are different *classes*, which specify the intensity of the treatment. Which care needs correspond to which functions and classes, is laid down in the Care Entitlement Regulation[2] .

In addition, a patient needs to pay a personal contribution.

The solution is shown in Figure 7. Now there are two verification steps (Table 6): In the first step, Evidence of Care Needs (Supporting Document) is compared with the Care Entitlement Regulation (Document-to-be-verified). The result is modeled as a Right for Functions. This assessment is performed by a national agency, called Central Indication Center[3] In the second step, the local Administration Offices translates the Right for Functions into an actual Right for Care. Because the administration office has an overview of the available care providers in a region, this actor is in a position to advice patients on where to get the best care they need.

Table 6 Applying Pre-execution to Problem 2a en 2b

Name	Pre-execution Verification
Context	Government (primary actor) entitles all citizens (counter actor) to exceptional healthcare (primary object),
Problem	2a. Government is not certain if the entitlement for care corresponds to actual care needs of a patient, as detailed in the Care Entitlement Regulation 2b Needs assessment must be uniform, but the available care supply depends on the region.
Solution	Step 1. based on evidence of care need, CIZ makes an assessment of the care needs of a patient, and issues an evidence document: Right for Functions.. Step 2. The Administration Office translates the Right for Functions into Right for Care, allocating care services and care providers.

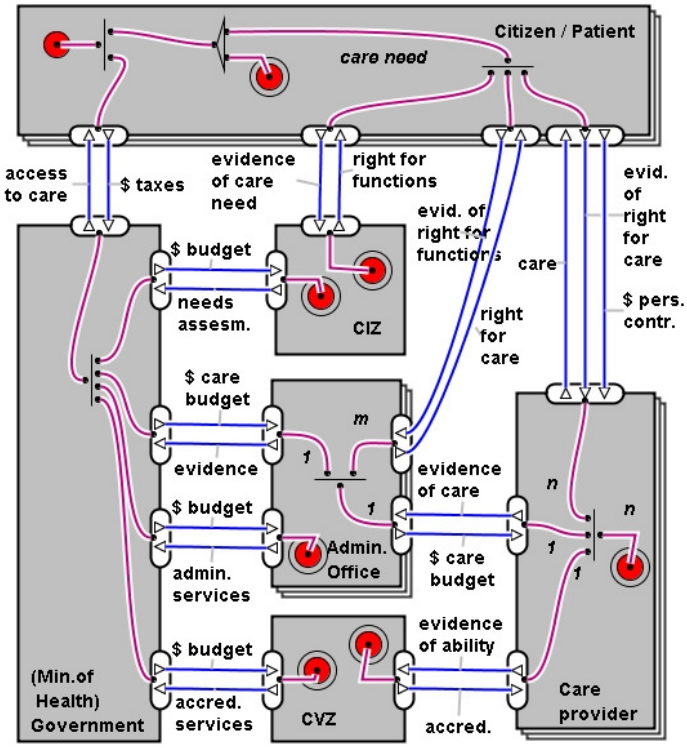

Figure 7. Current Exceptional Healthcare Network

[2] Besluit Zorgaanspraken AWBZ

Control problem 3: Until now, no actor in the network controls the quality of care products. As a result, provisioning of care of low quality could remain undetected. In the previous step, administrative evidence is used for budget control of care providers, but no evidence of the quality of care is used.

However, a basic form of quality control does exist. The government is in a position to select care providers. Before being allowed to enter the network in the first place, the ability of care providers to provide the care functions for which they are known, must be assessed. This accreditation is the result of applying the pattern Certification. Accreditation is delegated to the Healthcare Insurance Board[4] (CVZ). So in Figure 7, the Administration Office can only assign patients to care providers who have an accreditation from the CVZ. The CVZ cannot provide real quality control, but it based on administrative evidence, it can at least ensure that the care provider has adequate facilities.

Table 7 Applying Certification to Problem 3

Name	Certification
Context	Government (primary actor) provides budget (primary object) through Administration office, to care providers (counter actor), who in return provide care (counter activity) for patients.
Problem	Government is not certain if the quality of the care delivered corresponds to certain basic quality standards and requirements.
Solution	The basic abilities of the care provider are verified, The result is an accreditation.

3.2 Personal Budget and the Social Chart

The exceptional healthcare system described above has a number of problems. The right for healthcare, through needs assessment, is disconnected from the care that is actually available. For each care provider, the budget from the government has a limit. Care providers do not have an incentive to provide services above their budget. Moreover, this supply-driven system results in a fragmented and unbalanced care supply in some regions. Therefore the government is moving towards a demand-driven system

To try and solve these problems, the government introduced the possibility for patients, to buy their own care services, from a so called Personal Budget[5]. The personal budget is allocated by the Administration Office, on the basis of the Right for Functions. The Personal Budget can cover care from any of the following six functions: domestic care, personal care, nursing, supportive assistance, activating assistance, and short term institutional care. The budget does not cover medical treatment, permanent institutional care or pharmaceuticals. Furthermore, the rules for care providers are liberalized. A care provider may now be any institution or private person. This liberalization has led to an enormous growth in the number of care providers, which creates more choice for patients, and in some cases allows them to regain control over their lives. We call these new care providers alternative care providers. This situation is shown in Figure 8.

From a control perspective, we can observe the quality control problem again. Because of the large number of alternative care providers, there is no way that the CVZ can accredit all of them. Therefore, alternative providers are generally not required to have an accreditation from the CVZ. In Figure 8 the scenario with a Personal Budget is modeled.

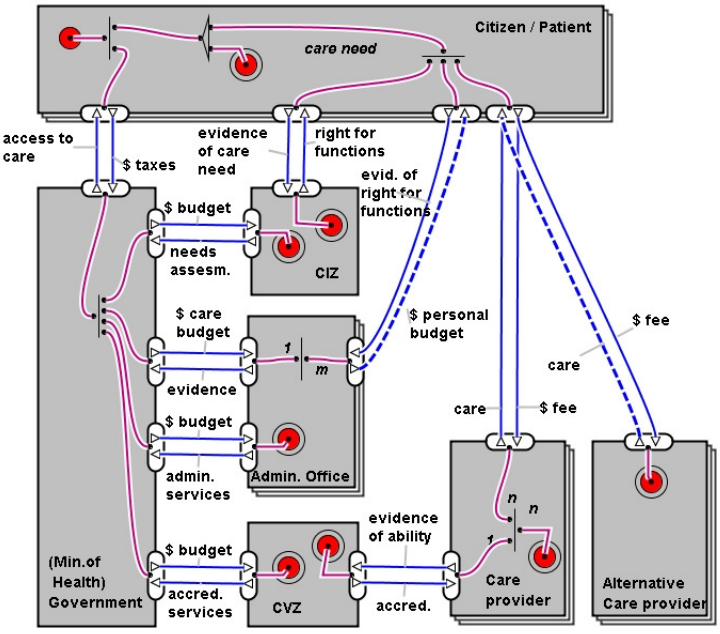

Figure 8. Personal Budget

Control problem 4: Patients and relatives are not adequately informed about the available care, and care providers in a region. Only information about accredited care providers is available from the Administration Office. Patients therefore tend to select traditional care providers, rather than alternative care providers. This may stifle the development of the market for alternative care providers. This observation corresponds to the general idea that *information asymmetry*, a situation in which the customer has less information about a product than the provider, has a negative effect on the emergence of new markets [3]. In Figure 8, this control problem is represented by a sub-ideal exchange (dashed line), labelled 'care'.

Control problem 5: There is a risk that low quality care is delivered by alternative care providers (dashed line for 'care'). We can also see the problem from the government's point of view. If patients select care providers that provide inadequate quality, public money is wasted. This is indicated by a dashed line for `Personal Budget'.

In an e-commerce setting, the first problem would typically be solved by an information broker, who matches supply and demand. The second problem would be solved by an agency verifying reliability. Since these activities require special expertise, it makes sense to delegate them to a separate agent. To solve these problems, we must select a pattern from the pattern library. We dismissed the possibility of a regulatory body assessing quality, because of the large number of alternative care providers. So the Certification pattern can not be used. Control problem 4 (lack of information) seems to be related to *partner selection*. However, as it stands, the partner selection pattern does

[3] Centrum Indicatiestelling Zorg (CIZ)
[4] College van zorgverzekeringen (CVZ)
[5] Persoonsgebonden Budget (PGB)

not deal with the general information needed to collect a set of feasible providers (see definition in Table 1). It only deals with the second half of partner selection: reliability assessment. Now we could adapt the patterns to accommodate this problem, but in this validation test, we have chosen to keep the patterns as they are, and conclude that they do not completely cover all aspects of the case study.

Although not generated by a pattern, we do have a possible solution. The information problem can be solved by providing an information service, such as the Social Chart introduced at the beginning of this paper. In Figure 9 this solution is represented.

Regarding problem 5, quality control is a general concern in Dutch healthcare. Since 2004, an independent Health Inspectorate (not in the model) supervises the quality of institutional care providers. But this organization cannot feasibly control the large number of alternative care providers. We therefore propose that an initiative like the Social Chart should enable a kind of *informal quality control*. It could provide, for example, a web-forum with testimonials, an online community peer review, a reputation mechanism, or collaborative filtering techniques [25]. In this manner, knowledge about the quality of care providers can be shared throughout the community of patients and relatives. Community-based quality control only works when users contribute to the community. That is why in the scenario shown in Figure 9, the Social Chart receives Quality Assessment from (some) patients.

Table 8 Applying Partner Selection to problem 5

Name	Partner Selection
Context	Patient (primary actor) pays a fee (primary object), taken from the personal budget to alternative care providers (counter actor), who provide care (counter activity) .
Problem	Patient is not certain if the quality of the care delivered some care provider, corresponds to certain quality standards and requirements.
Solution	Witness past performance of care providers. Verify past performance against norms. Witness and verify reputation. Witness quality assessments of patients. Use these assessments to select a care provider, before requesting care. NB 1. Selection is usually delegated to a family member or general practitioner. NB 2. Gathering quality feedback can be delegated NB 3. Quality control may depend on quality assessments from patients (solidarity)

The Social Chart could be partly funded by the Administration Office. It is the Administration Office's responsibility to provide an overview of the services in one region. So we have modeled an exchange of Information Services in return for Budget. Because quality control is a govern responsibility, one could also argue that the development of an infrastructure for informal quality control should be subsidized. So, in Figure 9, a value exchange Quality Assessment Services is drawn between the Social Chart and the Ministry of Health in return for Subsidy.

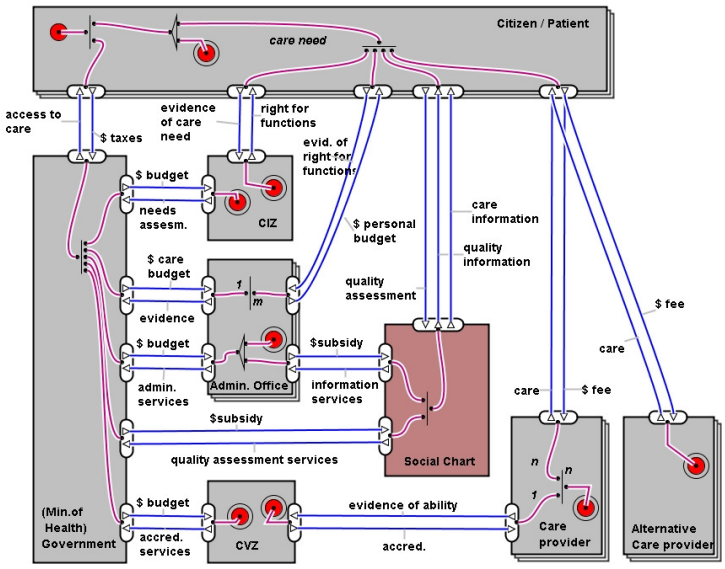

Figure 9. Possible Scenario for Social Chart (value model)

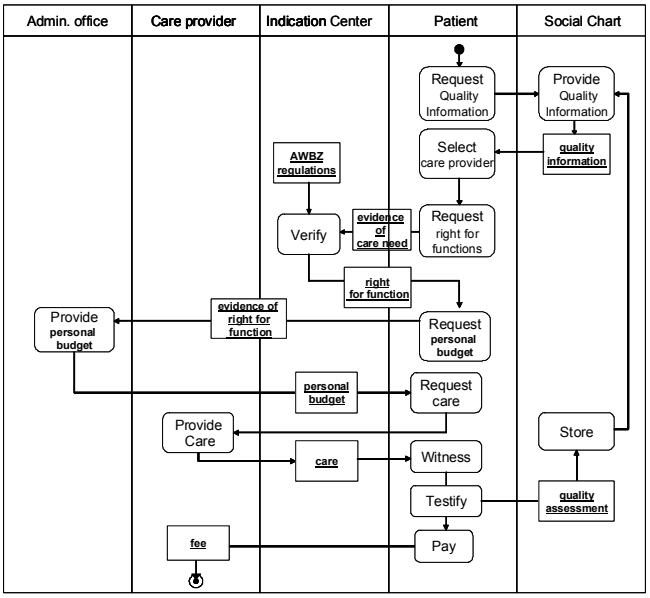

Figure 10. Possible Scenario for Social Chart (process model)

3.3 Exploitation of the Social Chart

Figure 9 presents only one of many possible exploitation scenarios. The Social Chart could be set up for example by the patients' association, by commercial parties like an insurance company or information broker, or by government. There are some indicators that virtual communities of patients are able to provide a form of community-based quality control. [9]. There are already many successful virtual communities for patients with a chronic disease. For example, Leimeister et al [17] discuss the characteristics of a forum for cancer patients. Regarding dementia care, we find a relatively successful virtual community, hosted by patients association 'Alzheimer Nederland'. In the framework of the National Dementia Programme, Alzheimer Nederland

collaborates with local government to improve dementia care [19]. So a combination of the patients' organization and local government seems a viable option for setting up and exploiting a kind of Social Chart

Getting reliable online feedback is difficult [25].. Personal testimonials tend to be biased. Luckily, also quantitative approaches exist. For example, a Dutch information broker, independer.nl, is using a panel of general practitioners to get statistically valid feedback on the quality of hospitals.

3.4 Discussion

The objective of the case study is to validate the use of the control patterns. In particular, we are interested in modeling a highly regulated setting, with public-private partnerships.

3.4.1 Regarding the use of Control patterns

Control patterns have a 'constructive' element, but reconstruction can also be used for analytic purposes. In this case study, we applied the control patterns to a hypothetical healthcare system based on solidarity. We have re-engineered the administrative control mechanisms in the AWBZ. We have shown that crucial aspects of the AWBZ controls can be motivated by the application of control patterns. In particular, the evidence documents (needs assessment, evidence of ability to provide care) are generated by application of the pre-execution verification pattern. Quality control is established by applying the partner selection pattern, or by applying the certification pattern when executed by a regulatory body. Budget control arrangements can be seen as a kind of transaction, with mutual commitments laid down in a contract. In addition, the delegation of tasks to separate agencies makes a large difference. So although delegation is not a control pattern, it does play a role as an organizational pattern. However, providing information about care providers and the care supply, the first function of the Social Chart, could not be established as the result of a control pattern.

In addition, the analysis demonstrates that there is a quality 'control gap' for alternative care providers. We have indicated a particular solution to fill this control gap: an interactive Social Chart, which could provide information about care supply and care providers in region, and possibly provide community-based quality control. The use of quality feedback to make a decision can be interpreted as application of the partner selection pattern.

We have only highlighted some aspects, ignoring others. In particular, we have had little to say about the information aspects of the administrative procedures. For this case study, the control patterns are too much focused on processes and administrative control, and too little on information and evidence.

3.4.2 Regarding highly regulated environments

The use of a value-based modelling technique in a highly regulated setting raises some issues for discussion. For more on these issues we refer to [16]

Indirect reciprocity. In this case study, the economic reciprocal relation is often indirect. This is modelled in e3-value by a broken dependency path (thin line). People pay only for access to a service (triangle). In any insurance, the insurance premiums (here from taxes) should cover the claims from patients.

Regulatory rights Public-private partnerships are heavily regulated. Regulation can take the form of a system of legal rights, to restrict access to a service. Examples in the case study are Right for Functions and Right for Care. Legal rights can be seen as a value object in the *e3-value* ontology.

Evidence documents This case shows the need for various evidence documents. Although collection and interpretation of evidence is usually modelled as part of the regular business process, here evidence documents are seen as value objects.

Community-based reciprocity A community-based quality control, like a recommender system, only works when members contribute Sharing and exchanging information, like experiences about care providers, can be based on solidarity in a community.

Control services A control service like needs assessment can be seen as a separate service, which can be delegated. This is highlighted in the model. All parties, including government agencies, need to be funded

4. CONCLUSIONS

The healthcare sector is subject to a constant revision. In general, it is much harder to set up and maintain an information service, when the context is subject to change. When regulations change, the business opportunities may well change too. Therefore a generic method for analyzing and developing governance and control mechanisms for network organizations is needed. Control patterns provide such a method.

A *control pattern* is a description of a generic and re-usable control mechanism for a recurring control problem, to be selected on the basis of the context of application. Like design patterns, control patterns capture 'best practices' in a domain. Based on accounting literature and various case studies, we have developed a representation language for expressing control patterns, and a library of generic control patterns.

In this paper we have validated the control patterns, on a case study in healthcare. We have reconstructed the development of the governance and control mechanisms of the AWBZ system for provision of exceptional care. The case study shows that crucial aspects of the administrative controls can be motivated by the control patterns. In particular, evidence documents, like the needs assessment are generated by the pre-execution verification pattern. Quality control can be established by partner selection or certification. Budget control arrangements can be seen as the application of the proper contracting pattern, just like in business contexts. So the control patterns have proved to be useful and adequate in analyzing this case study.

However, there are also some limitations. The patterns focus on process aspects and administrative controls. Much less attention is paid to information and evidence collection. This is unfortunate for this case study, because information provision is one of the main functions of the Social Chart. Management information issues have not been studied in this paper.

ACKNOWLEDGMENTS

We would like to thank the members of the FrUX project for their valuable input, in particular Rose-Marie Droës and Franka Meiland of the Vrije Universiteit Medical Center.

5. REFERENCES

[1] C. Alexander. The Timeless Way of Building. Oxford, Oxford University Press, 1979.

[2] Z. Baida, Software-aided Service Bundling - Intelligent Methods and Tools for Graphical Service Modeling, PhD thesis, Vrije Universiteit Amsterdam, 2006.

[3] Y. Bakos, The Emerging Role of Electronic Marketplaces on the Internet, Communications of the ACM 41(8), 1998, pp 35-42.

[4] M. Beedle, M. Pattern Based Reengineering. Object Magazine, January, 1997.

[5] R. W Bons,., R.M Lee, and R.W Wagenaar, Designing Trustworthy Inter-Organizational Trade Procedures for Open Electronic Commerce. International Journal of Electronic Commerce, 2(3):61–83., 1998.

[6] K. Chen, Schematic Evaluation of Internal Accounting Control Systems. PhD thesis, University of Texas at Austin, 1992, available as K. Chen, and R.M. Lee, EURIDIS Research Monograph RM-1992-08-1, 1992.

[7] J. O. Coplien,., N.B. Harrison, Organizational Patterns of Agile Software Development, Prentice Hall, 2004.

[8] R.M. Dröes, F.J.M. Meiland, C. Doruff, I. Varodi, H. Akkermans, Z. Baida, E. Faber, T. Haaker, F. Moelaert, V. Kartseva and Y.H. Tan, A dynamic interactive social chart in dementia care. In: L. Bos, S. Laxminarayan and A. Marsh (eds.), Medical and Care Compunetics, Studies in Health Technology and Informatics 2(114), IOS Press 2005.

[9] A. Dannecker, U. Lechner Success Factors of Communities of Patients, Proceedings of the 14th European Conference on Information Systems (ECIS 2006), Göteborg, 2006.

[10] M.F. Drummond. Methods for the economic evaluation of health care programmes, Oxford University Press,. 2005.

[11] A. Exter, H. Hermans, M. Dosljak, R. Busse, Healthcare systems in transition:Netherlands. WHO Regional Office for Europe, Copenhagen, 2004.

[12] E. Gamma, R. Helm, R. Johnson, and J. Vlissides. Design Patterns: Elements of Reus-able Object-Oriented Software. Addison Wesley, Boston, 1995.

[13] J. Gordijn, J.M. Akkermans, Value-Based Requirements Engineering: Exploring Innovative E-commerce Idea. Requirements Engineering Journal, Springer Verlag, 8(2), 2003, pp. 114-134.

[14] V. Kartseva, J. Gordijn, Y.-H. Tan, Towards a Modelling Tool for Designing Control Mechanisms for Network Organisations. International Journal of Electronic Commerce, 10(2), 2005, pp. 57–84.

[15] V. Kartseva, J. Gordijn, Y.-H. Tan, Inter-Organisational Controls as Value Objects in Network Organisations, accepted by the 18th Conference on Advanced Information systems Engineering (CAiSE), Luxembourg, 2006.

[16] V. Kartseva, J. Hulstijn, J. Gordijn, and Y.-H. Tan, Modelling Value-based Inter-Organizational Controls in Healthcare Regulations, in Proceedings of the 6th IFIP conference on e-Commerce, e-Business, and e-Government (I3E'06), Turku, Finland, 2006.

[17] J. M Leimeister.; M. Daum,. and H. Krcmar., (2004) Towards mobile communities for cancer patients: the case of krebsgemeinschaft.de, International Journal on Web Based Communities, 1(1), 58–70.

[18] R. Mayer, J. Davis, and F Schoorman. An integrative model of organizational trust. Academy of Management Review, 20(3), 1995, pp. 709–734.

[19] J. Meerveld, J. Schumacher, E. Krijger, R. Bal, and H. Nies, *Werkboek landelijk dementieprogramma*, Nederlands Instituut voor Zorg en Welzijn (NIZW), 2004.

[20] R. Motschnig-Pitrik, P. Randa, and G. Vinek. Specifying and analysing static and dynamic patterns of administrative processes. In Proceedings of the 10th European Conference on Information Systems (ECIS 2002), Gdansk, Poland, 2002

[21] A.G. Pateli, G.M. Giaglis, A Research Framework for Analysing Business Models, European Journal of Information Systems, 13(4) 2004, pp. 302-304.

[22] M.B. Ronmey, P.J. Steinbart, Accounting Information Systems (9th edition). Prentice Hall, New Jersey, 2003.

[23] J. Rumbaugh, I. Jacobson, and G. Booch, The Unified Modelling Language. Addison Wesley, 1999.

[24] R.W. Starreveld, B. de Mare, E. Joels, Bestuurlijke Informatieverzorging (4th ed), Samsom, Alphen, 1994

[25] P. Schubert, M. Ginsburg, Virtual Communities of Transaction: Personalization in Electronic Commerce. Electronic Markets, 10(1) 2000, pp. 45–55.

[26] I. Seruca and P. Loucopoulos. Towards a systematic approach to the capture of patterns within a business domain. Journal of Systems and Software 67, 2003 pp 1–18.

[27] A. Osterwalder. The Business Model Ontology: A Proposition in a Design Science Ap-proach, PhD thesis, University of Lausanne, Lausanne, Switzerland, 2004.

[28] D. Tapscott, D. Ticoll, A. Lowy, Digital Capital - Harnessing the Power of Business Webs, Nicholas Brealy Publishing, London, UK, 2000

[29] O.E. Williamson. Transaction Cost Economics: The governance of contractual relations, Journal of Law and Economics, 22, 1979, pp. 3-61