Radboud Universiteit Nijmegen

Master thesis

FORMULATING PRINCIPLES IN AN EFFECTIVE WAY

Author	: Bertram Ramspeck
Thesis no.	: 75 IK
Student no.	: s0544558
Education	: Information Science
Supervisor	: Prof. dr. Erik Proper
Reviewer	: dr. S.J.B.A. Stijn Hoppenbrouwers
Date	: February, 2008
Version	: 1.0

Preface

This thesis is based on a research and a workshop performed by Bertram Ramspeck, Information Science student at the Radboud University Nijmegen. The thesis is based on a method for developing enterprise architectures developed by the IRIS group. I had the opportunity to apply the method for a first time trough a real life workshop. The workshop is executed for the Denver International Program (D.I.P) at the University of Denver.

D.I.P. needed a new software architecture based on principles. To achieve this I applied the method and reflected the results in the thesis. The results of DIP are not discussed in here.

Chapters

Problem description

Introduction

More and more IT is an essential part of an organization. In the early days the focus in IT was strongly on the hardware, nowadays the focus on software is getting more important. Security and requirements are a big issue. Therefore the process of developing software is getting really important so these issues can be taking along in the architecture.

Organizations have to migrate or transfer from their legacy systems to a new software information system. In this step there are some large off-the-shell programs; also called Enterprise Resource Planning (ERP). These packets can be adjusted to the organization and can mostly cover a big part of the organization. An organization can also choose for a custom-made software system; a system build from the beginning and fully focused on the organization. This method is more expensive and time consuming but the result is a system that completely fits the organization (enterprise). The difference between enterprise architecture and Architecture is its entire scope. Enterprise architecture is the highest level what itself expatiate from the strategy to the technical infrastructure. Because of the complexity and the overall helicopter view an enterprise architecture allows the architect to manage and align business processes for improvement or competitive advantage.

Motivation

Increasingly, organizations make use of enterprise architectures to direct the development of the enterprise as a whole and its IT portfolio in particular (2005-Lankhorst-ArchiMate). These developments are fuelled by requirements such as the Clinger-Cohan Act in the USA, which force government bodies to provide an IT architecture [TEE07].

So an enterprise architecture is the best view for an organization to achieve their core goals related explicitly to the organization's strategy. These days several working groups have different perspectives about the definition of enterprise architecture (see chapter “Enterprise Architecture”). In this thesis (based on the Principle Arena) we consider principles as the cornerstone of enterprise architecture [PA07].

Because the bigger need of organizations to improve and adjust their system to the core strategy of the organization it becomes more important to further develop the enterprise architecture and the process to come to an enterprise architecture. The purpose of this thesis is to finish my Information Science master and to further develop architecture principles for the improvement of the enterprise architecture. This step in the development of an enterprise architecture is of big importance for the reason that principles are the basis of an enterprise architecture. Also the relation between principles and enterprise architecture is immature. Immature in ways of the different viewpoints about what a principle exactly contents and the different viewpoints about the relevancy and

importance of principles in an enterprise architecture. With this thesis I want to make principles clear and understandable and illustrate the close relation to an enterprise architecture.

Problem definition

Enterprise architecture is a framework used to manage and align business processes in an organization; it provides a common basis for understanding and communicating how systems (processes) are structured to meet strategic objectives. It leads to simplification which allows stakeholders better prioritization and justification.

The standard definition from IEEE describes architecture as: “The fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution” [IEEE].

Within enterprise architecture the use of principles is common and often based on principles. These principles in enterprise architecture are called architecture principles and are mostly mend for a reference in implementation projects. In this thesis we consider the principles as the cornerstone of an enterprise architecture. Because of this I will formulate principles in a workshop using a certain approach.

I will use the approach developed by the IRIS group [IRIS]. It is more like a method or description how to develop enterprise architectures, in particular the architecture principles. This method handles the design constraints by controlling and measuring it by making principles specific and measurable enough to allow them to control design space. There are unlimited ways to construct an enterprise architecture. In this paper the focus is on the Principles Arena [PA07]. The Principles Arena project takes the form of a joint working group of the NAF and the ArchiMate Foundation. They regard enterprise architecture as having a regulating and designing perspective. The ArchiMate project took a design perspective on architecture. The Principles Arena project aims to complement this work by taking a regulating perspective.

According to the Principles Arena there are three classes of principles. In the next three classes principles can be distinguished.

1. *Principles as emergent laws.* These are essentially properties of (classes of) a system that can be observed and validated. Examples are the laws of nature, law of requisite variety, laws of social behavior, etc.
2. *Principles as imposed laws.* Like emergent laws, they are properties that can be validated. However, imposed laws also require mechanisms to enforce them. Imposed laws typically address concerns of stakeholders. Some of these concerns may be raised by emergent laws having a negative Formalizing Architecture Principles with ORM 2 impact on the system / enterprise being designed. Examples are: societal laws, policies and regulations within organizations, etc.
3. *Principles as guidelines*. Desired properties that are so concrete that they offer guidelines to make operational behavior fit imposed laws. For example: “Always use your car’s cruise control” is an advisable property to abide by that provides guidance in obeying the law concerning maximum speeds on roads.

In this thesis we will focus on *principles as imposed laws* and *principles as guidelines*.

A principle originates from a concern of one or a group of stakeholders. Concerns come from the strategy of an organization to personal reasons. In every situation the principle must **always** be related to the concern of the stakeholder(s). Principles are formed in rules, guidelines and standards.

Enterprise architecture is principle oriented and therefore it is of great importance that the principles are understandable and one-way. A wrong or imprecise principle can lead to big troubles in the organization. To limit this *the Open Group* [TOGAF] listed five criteria's that distinguish a good set of principles:

1. Understandable: The underlying tenets can be quickly grasped and understood by individuals throughout the organization. The intention of the principle is clear and unambiguous, so that violations, whether intentional or not, are minimized.

2. Robust: Enable good quality decisions about architectures and plans to be made, and enforceable policies and standards to be created. Each principle should be sufficiently definitive and precise to support consistent decision making in complex, potentially controversial, situations.

3. Complete: Every potentially important principle governing the management of information and technology for the organization is defined. The principles cover every situation perceived.

4. Consistent: Strict adherence to one principle may require a loose interpretation of another principle. The set of principles must be expressed in a way that allows a balance of interpretations. Principles should not be contradictory to the point where adhering to one principle would violate the spirit of another. Every word in a principle statement should be carefully chosen to allow consistent yet flexible interpretation.

5. Stable: Principles should be enduring, yet able to accommodate changes. An amendment process should be established for adding, removing, or altering principles after they are ratified initially.

If a principle meets the above criteria's it can be documented. The Integrated Architecture Framework [IAFv3] prescribes a principle with its name, description, motivation, implication and assurance.

Doc-part	Definition
Name	Essence of the rule, easy to remember
Description	Brief, clear & precise/unambiguous statement of the principle
Motivation	Rationale behind the principle (benefits, intentions, relationship with other principles)
Implication	Impact of the principle, e.g. on other

	principles, design, maintenance
Assurance	What & how will be measured to verify that this principle is achieved

After principles are formulated they can be further anatomized in terms of formalization. The focus of formalization is that, when properly and systematically performed, may also lead to better analysis of certain patterns of meaning underlying the principles, and thereby to improvement of the (formulation of) the principles as such –even of their informal formulations [BOM06]. Principles will be formalized with ORM (Object Role Modeling) and ORC (Object Role Calculus); because of its formal foundations, its close relation to the BRA (Business Rules Approach), and its long running affiliation with cooperative domain modeling involving varied, often non-technical domain experts [BOM06].

With these formalizations we can look at the quality of these models and say more about the effect of the principles. It is difficult to say when a set of principles is effective but with the formalization and using a model quality framework it become more measurable. Richard Y. Wang and Diane M. Strong created the Conceptual Framework of Data Quality which allow us to apply on the principles.

John Krogstie [KROG03] has developed a framework to measure the quality of models. Krogstie measure in different levels of quality and evaluates the whole model. Krogstie measures in physical-, empirical-, syntactic-, semantic-, pragmatic-, social- and organizational quality. With the IRIS approach, the results of the workshop and Krogstie's quality framework I will build up a framework especially for the IRIS approach.

All the above problem areas are related to the problem definition:

"How to formulate principles in an effective way?"

The scope of the problem definition is too large to cover in this thesis. In this thesis I will answer the problem definition while applying a certain approach. I will perform a research about the problem and applying a certain method in a workshop. The research will focus on the approach, expatiations, process and conclusions. The workshop will be based on a real-life application working in the D.I.P. (Denver International Program) project for finding and formulating principles, ensuring shared understanding and shared commitment for the impact of these principles and taking both collaborative and cause-effect reasoning into account. The research will be based on the process of applying the method on the real-life application and the method itself whereby a new framework will be constructed to measure the effectiveness of a set of principles.

Objectives

With the problem definition the goal is to further develop enterprise architecture, specifically principles within the enterprise architecture and thereby adjust and improve a specific approach. This will be obtained by reports, evaluations, feedback, suggestions and a quality framework constructed during the research. These expected results will deliver new key questions for possible further research and a framework to *measure* the effectiveness.

I expect, with applying the given approach that I can formulate principles that are useful and unambiguous. To measure the effect of these principles I will construct a framework so the principles originating from the approach and the workshop can be measured in terms of how effective they are. "How effective" a principle is will be based on the framework constructed during the research and workshop. This framework will be based on the process, product and compliance.

As a result of this thesis it should be possible to say something about a principles in terms of construction, consistency, unambiguously, formalization model, effectiveness, etc.

A big factor of the approach will be the cost / benefits relation. The costs should never be higher than the benefits seen from a business perspective. This implies that the overall positive results and the effectiveness only can be achieved when the costs are lower than the benefits. So within the realization of the specific approach I will take along the costs and benefits of the whole project. To compare this the costs (time, labor, materials, etc.) will be compared to the benefits (results, achieved goals, compliance, etc.). An important factor to measure the benefits is the compliance and thereby the effectiveness of the principles. I expect the constructed framework can handle and measure in these terms.

Research questions

The following problem definition is not focused enough. I will make it more concrete with some research questions to make it more clear and focused.

"How to formulate principles in an effective way?"

The research question to answer the problem definition are

- *Is the specific approach clear and feasible?*
    - Are the steps clear and unambiguous?
    - Is my interpretation also the same as the intention?

- *Are the principles consistent and unambiguous?*
    - Does the set of principles have contradictory's?
    - Is the set of principles understood by each stakeholder?

- *How will effectiveness be measured?*
    - Are the formalized principles comply with Krogstie's Quality Framework?
    - Cost / benefits?

- *How are the costs relating to the benefits?*
    - What are the affected costs?
    - What are the benefits?
    - How is this measured?

- *Is the set of principles compliant to?*
    - What did D.I.P. do with the principles?
    - Why did or did not D.I.P. adapt the set of principles?

Research objectives

Here I will make the research questions more concrete in terms of deliverables, applications, etc.

- *Is the specific approach clear and feasible?*

This question will be answered trough out the whole project. While applying the approach it will be clear of the approach is clear and feasible. This will be measured by my interpretation and the questions I will have while applying the approach. My interpretation, results and questions will be reflected in this thesis. Also my interpretation and the meaning of the approach will become clear while applying the approach and communicating with my supervisor.

- *Are the principles consistent and unambiguous?*

This question will be answered while formalizing the principles. In the formalization stage all inconsistency's and unambiguously will become clear. If all problems are solved the set of principles will be criticized by the stakeholders. The intention and the expectation is that there are no more disputes between the stakeholders and that the intention of all principles will be univocal.

- *How will effectiveness be measured?*

Effectiveness is difficult to be measured. The effectiveness will be measured in process, product and compliance. For measuring the process I will construct a framework. The effectiveness of the product will be measured by the Quality framework of Krogstie, this will measure the quality and therefore the effectiveness in a later stage. The compliance will be measured afterwards by interviewing D.I.P. The new framework will include these three steps and so we can measure the total effectiveness.

- *How are the costs relating to the benefits?*

This question will be answered afterwards when the costs and especially the benefits are mapped. The costs will be measured in time, labor, product costs. This will be done through the whole project. At the end and afterwards the benefits will be measured in terms of effectiveness and the use of the principles in the practice. After the costs and benefits are mapped we can say something about the costs related to the benefits.

- *Is the set of principles compliant to?*

This question will be answered subsequent to the end of the project by interviewing D.I.P. It will be clear of D.I.P. adapted the principles and in which way or that D.I.P. didn't adapted the principles but only uses them for insight. In both ways we will be see the "why" and the indicators. Also the afterwards problems will come up in the interviews.

Research approach

Justification

The recently developed approach by the IRIS group is never tested before in a real time situation. This means that there are no articles or any kind of information about best practices. There are several working groups working on this issue. These working groups like the ArchiMate project [ARCH] and the TOGAF openGroup [TOGAF] achieving the same goal but with a different perspective on architecture. The Principles Arena project aims to complement the work by taking a regulating perspective.

Scoping

The transition from the legacy system to the new system is a wide process. In the development of the Principles Arena as a laboratory environment for running experiments with the formulation of architecture principles, we identify the following steps:

1. Creation of an initial process and support: The goal of this first step is the creation of an initial way of working and way of supporting guiding/supporting the creation of architecture principles. This way of working will take us from concerns to informal principles. The tooling will mainly support the capturing of the deliverables, as well as the logging of the executed process.

2. Measuring the quality of the process: The goal of the second step is to be able to measure the quality (a way of evaluating) of the way of working followed in the creation of the principles. This involves the identification of quality properties to be evaluated, evaluation mechanisms and tool support to enable these quality evaluations.

3. Experimentation with different processes: This step demands the laboratory to be flexible enough to experiment with different configurations/variations of the way of working.

4. Extension with formalization: The goal of this step is to extend the way of working, way of evaluating and way of supporting to also cover the creation of formalized principles, define measuring metrics and create associated enforcement strategies.

5. Extension with rationalization: The first steps took concerns as a starting point. Principles must indeed address concerns, but they should ultimately be motivated in terms of goals of the business/stakeholders, risks that may hamper the attainment of these goals, etc. These will all influence the selection and further elaboration of principles.

6. Integration of model builder abilities: This step involves the integration of a model builder. The formal representation of architecture principles in terms of ORC requires an underlying ORM model. The creation, and validation, of this model should be integrated into the laboratory, also enabling an integration of the associated modeling process.

The workshop will be aimed on step 2, *Measuring the quality of the process.* Thus, this thesis focuses on the process (quality) of formulating and formalizing principles (definition) and less on the gathering of principles. The formulating and formalization process of the principles is done by a step-by-step process through the specific approach.

Thus the actual focus is on the method (the process) and its effectiveness and **not** on the actual results of the real-life application. The results of the real-life application are essential for D.I.P but will not be significant for this thesis but they can function as examples.

The results in the thesis will help to analyze and criticize the approach for further development and possibly additional research. Most relevant information will be gathered while actually working in the real-life application with the approach and by studying information.

Methods

This workshop will be conducted at the D.I.P. on the University of Denver where the development of a software architecture is needed.

Research will start by identifying concerns and issues by working in the organization through the real-life application, reading literature and by interviewing the stakeholders. This information will be gathered from The Council of International Programs USA (umbrella organization of D.I.P.), D.I.P. itself, interviews with my mentor / important persons / stakeholders (users, administrators and security people) within the project. The collected information will flow from concerns to informal principles which will be measured on quality afterwards.

Subsequent to collecting the relevant information, the formulation and prioritizing phase (consultation the management) of the principles (rules, guidelines and standards) will start.

After fully understanding and shared commitment of these principles by stakeholders, they will be formalized in Object Role Calculus (ORC) and Object Role Modeling (ORM). The formulization phase

will track faults and give a better insight into contradictions. So after this phase the principles will be verified and will be set for implementation in the architecture.

In a more formal way of working the use of “The Principles Arena” [PA07] will be used. These steps will be constructed to a framework which I will use through my workshop. To give more meaning to the framework and the effectiveness I will improve and expand the framework.

As stated before, we prescribe a principle with its name, description, motivation, implication and assurance [IAFv3] whereby a principle meets the five criteria’s (understandable, robust, complete, consistent, stable) that distinguish a good set of principles by the openGroup [TOGAF]. We will also use a more standard method; the SMART method to double check the objectives of the principles. SMART will be measured in terms of Specific, Measurable, Achievable, Relevant and Time-bound as explained below:

Specific

- Specific in the context of developing objectives means that an observable action, behavior or achievement is described which is also linked to a rate, number, percentage or frequency. This latter point is extremely important. A good example: 'Answer the phone quickly' can be said to be a precise description of behavior, you can clearly see whether someone answers the phone or not, but there is no rate, number, percentage or frequency linked to it. So, if I state; 'Answer the phone within 3 rings' a rate has been added and the behavior is now much more specific.
- Summary: Is there a description of a precise or specific behavior / outcome which is linked to a rate, number, percentage or frequency?

Measurable

- A system, method or procedure has to exist which allows the tracking and recording of the behavior or action upon which the objective is focused. Setting an objective that requires phone calls to be answered in three rings is fine, provided a system exists which measures whether this is actually being achieved. If none exists the manager must be prepared to set time aside time to actually monitor the response rates to incoming phone calls. The only other alternative is to get the person with whom the objectives are being set to measure their own progress; in some cases and situations it may be acceptable to do this, in others maybe not.
- Summary: Is there a reliable system in place to measure progress towards the achievement of the objective?

Achievable

- The objectives that are set with people need to be capable of being reached, put most basically; there is a likelihood of success but that does not mean easy or simple. The objectives need to be stretching and agreed by the stakeholders. Setting targets that are plainly ridiculous does not motivate people; it merely confirms their opinion of you as an idiot. They will apply no energy or enthusiasm to a task that is futile.

- Summary: With a reasonable amount of effort and application can the objective be achieved?

Relevant

- This means two things; that the goal or target being set with the individual is something they can actually impact upon or change and secondly it is also important to the enterprise.
- Summary: Can the stakeholders with whom the principle is set make an impact on the situation? Do they have the necessary knowledge, authority and skill?

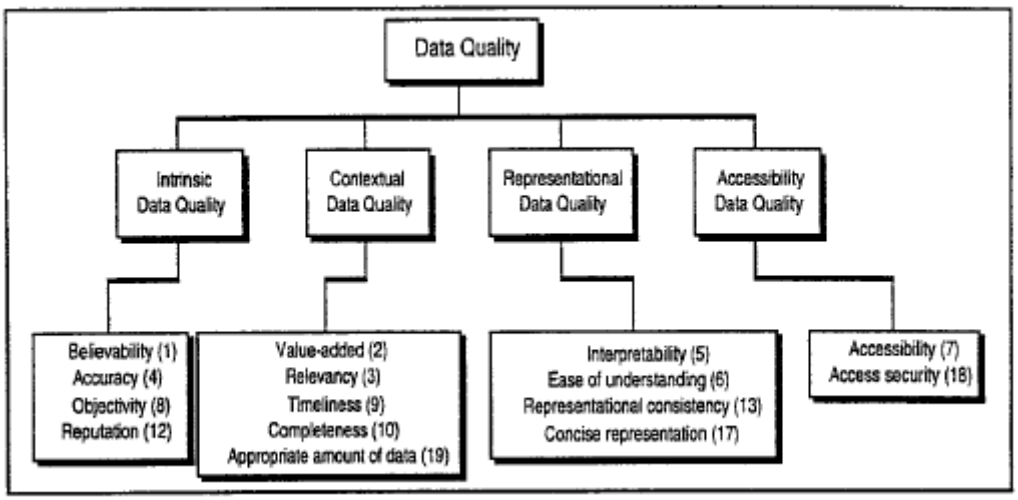
Time-bound

- In the objective somewhere there has to be a date for when the task has to be started (if it's ongoing) and/or completed (if it's short term or project related).
- Summary: Is there a finish and/or a start date clearly stated or defined?

After the principles are formulated and before we can say something about the effectiveness we have to be certain about the quality of information. Therefore we will use the Conceptual Framework of Data Quality created by Richard Y. Wang and Diane M. Strong [DQ96].

Like every data framework the aspects below should be common but not unimportant:

- The data must be accessible to the data stakeholder. For example, the stakeholder knows how to retrieve the data.
- The stakeholder must be able to interpret the data. For example, the data are not represented in a foreign language.
- The data must be relevant to the stakeholder. For example, data are relevant and timely for use by the stakeholder in the decision-making process.
- The stakeholder must find the data accurate. For example, the data are correct, objective and come from reputable sources



Conceptual Framework of Data Quality (Richard Y. Wang and Diane M. Strong)

The Conceptual Framework of Data Quality explained by Richard Y. Wang and Diane M. Strong [DQ96]:

Intrinsic Data Quality

Intrinsic DQ includes not only accuracy and objectivity, which are evident to IS professionals, but also believability and reputation. This suggests that, contrary to the traditional development view, data consumers also view believability and reputation as an integral part of intrinsic DQ accuracy and objectivity alone are not sufficient for data to be considered of high quality. This is analogous to some aspects of product quality. In the product quality area, dimensions of quality emphasized by consumers are broader than those emphasized by product manufacturers. Similarly, intrinsic DQ encompasses more than the accuracy and objectivity dimensions that IS professionals strive to deliver. This finding implies that IS professionals should also ensure the believability and reputation of data. Research on data source tagging [45,48] is a step in this direction.

Contextual Data Quality

Some individual dimensions underlying contextual DQ were reported previously; for example, completeness and timeliness [4]. However, contextual DQ was not explicitly recognized in the data quality literature. Our grouping of dimensions for contextual DQ revealed that data quality must be considered within the context of the task at hand. This was consistent with the literature on graphical data representation. which concluded that the quality of a graphical representation must be assessed within the context of the data consumer's task [41].

Since tasks and their contexts vary across time and data consumers, attaining high contextual data quality is a research challenge [29, 39]. One approach is to parameterize contextual dimensions for each task so that a data consumer can specify what type of task is being performed and the appropriate contextual parameters for that task. Below we illustrate such a research prototype.

During Desert Storm combat operations in the Persian Gulf, naval researchers recognized the need to explicitly incorporate contextual DQ into information systems in order to deliver more timely and accurate information. As a result, a prototype is being developed that will be deployed to the U.S. aircraft carriers as stand-alone image exploitation tools [33]. This prototype parameterizes contextual dimensions for each task so that a pilot or a strike planner can specify what type of task (eg., strike plan or damage assessment) is being performed and the appropriate contextual parameters (relevant images in terms of location, currency, resolution, and target type) for that

Representational Data Quality

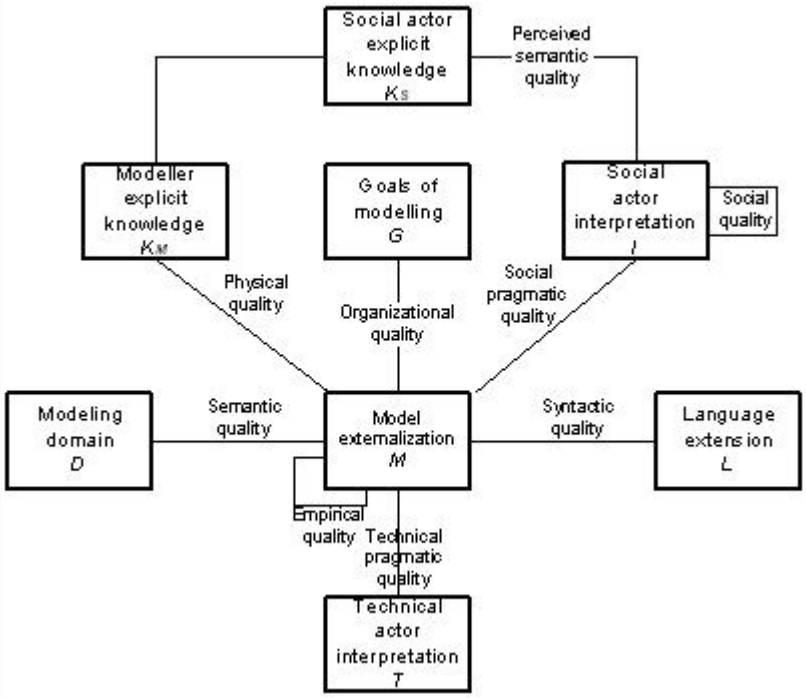
Representational DQ includes aspects related to the format of the data (concise and consistent representation) and meaning of data (interpretability and ease of understanding). These two aspects suggest that for data consumers to conclude that data are well represented, they must not only be concise and consistently represented, but also interpretable and easy to understand.

Issues related to meaning and format arise in database systems research in which format is addressed as part of syntax, and meaning as part of semantic recognition. One focus of current research in that area is Context interchange among heterogeneous database systems 1361. For example, currency figures in the Context of a U.S. database are typically in dollars, whereas those in a Japanese database are likely to be in yen. This type of Context belongs to the representational DQ, instead of contextual DQ, which deals with the data consumer's task,

Accessibility Data Quality

Information systems professionals understand accessibility DQ well. Our research findings show that data consumers also recognize its importance. Our findings appear to differ from the literature that treats accessibility as distinct from information quality (sce, e.g., [9]). A closer examination reveals that accessibility is presumed (i.c., perfect accessibility DQ) in earlier information quality literature because hard-copy reports were used instead of on-line data. In contrast, data consumers in our research access computers for their information needs. and therefore, view accessibility DQ as an important data quality aspect. However, there is little difference between treating accessibility DQ as a category of overall data quality, or separating it from other categories of data quality. In either case, accessibility needs to be taken into account.

Each step in framework will refer to the data quality framework. Each specific step will have different dimensions and different targets to measure the effectiveness specific to each step. If the quality of data is correct and we come to the step of formalization the quality of the ORM models will be measured with Krogtie's Quality of models framework. As stated before Krogstie measures in levels of quality. Below you will see the quality framework and these quality levels:



Krogstie's Quality Framework [KROG03]

- A: Actors that develop or have to relate to (parts of) the model. Can be persons or tools.
- L: What can be expressed in the modeling language
- M: What is expressed in the model
- D: What can be expressed about the domain (area of interest)
- K: The explicit knowledge of the participating persons
- I: What the persons in the audience interpret the model to say
- T: What relevant tools interpret the model to say
- G: The goals of the modeling

The framework represented these following levels:

Physical quality

• Externalization refers to a modeling language that is typically described in text and models. It is important that the meta-modeler ensures that the language model, including the language description, can be updated in a controlled way.
• Internalizability means that the relevant parts of the descriptions are available for those who need it in an efficient way (e.g., all users have access to the notation guide for those parts of the language they want to use).

Empirical quality

For empirical quality, a range of means for readability has been devised, (e.g., number of different readability indexes) for informal textual models. Other general guidelines include not mixing different fonts, colors etc. in a paragraph that is on the same level within the overall text. For graphical models in particular, layout modifications have been found to improve the comprehensibility of models. Thus for the textual part, the structure and readability of the text can be assessed. For meta-models and example models it can be judged whether the models are made aesthetically pleasing.

Syntactic quality
There is one syntactic goal of syntactic quality, syntactical correctness, which means that all statements in the model are in accordance with the syntax and vocabulary of the language. Syntactic errors are of two kinds: syntactic invalidity, in which words or graphemes that are not part of the language are used, and syntactic incompleteness, in which the model or text lacks the constructs or parts needed to obey the language's grammar. For the textual part of the language model, it should be verified that it is according to the language and structure chosen. Similarly, the model examples and meta models must follow the chosen syntax.

Semantic quality
The focus of semantic quality is semantic completeness (i.e., that all parts of the language are described in text and in the meta-model). Semantic validity of the language model focuses on whether the different descriptions are consistent both within and with each other. The language model should only describe the modeling language, and nothing more. It should be noted that in most language models, the domain is to a larger degree given "objectively" (e.g., in the definition by UML by what has been agreed upon through the standardization process).

Pragmatic quality
Pragmatic quality refers to the inclusion of a means to make it easier to understand the modeling language through the language model. This can include the use of indexes cross-references, and glossaries. It can also be done through tutorials, by linking of the model of modeling language to the use of the language in a modeling environment, etc.

Social quality
Social quality is an aspect that is relevant both in connection to the development of a standard language, and in connection to meta-modeling extensions. The representation of a language and its appropriateness can be disliked; therefore, good examples (e.g., use in the notation guide) is very important here.

Organizational quality
In regards to organizational quality, the model of the modeling language helps create efficient use of the modeling language for those tasks where it is meant to be used (e.g., minimize training time, etc.)

With the above knowledge and the experiences while applying I will construct a framework for measure the effectiveness.

Denver Case

Scope

The scope is set on DIPUSA. The architecture will eventually later be applied in the eight affiliate offices nationwide. Therefore the mission, vision, values and rules of the umbrella organization the Council of International Programs USA (CIPUSA) has to be considered. Also the rules CIPUSA will force on the affiliate offices and the communication between these offices will be taken along.

Within the scope all the concerns of the stakeholders will be included.

The relevant stakeholders:

- *Denver International Program*
- *Mentor*, Sue Koontz
- *DIP Executive Director*, Claudia Thesis
- *Project Assistance*, Matthias Hoekert
- *Board of Directors*, Debbie Jones, President
- *The Council of International Programs USA*, Umbrella organization of D.I.P.
- *Participants*
- *Host families*
- *Staff members*
- *University of Denver*, IT-Department

Collecting principles

First my research started by identifying concerns and issues by working in the organization, reading literature and by interviewing the stakeholders.

This information is gathered from CIPUSA (umbrella organization of D.I.P.), D.I.P. itself, interviews with my mentor / important persons / stakeholders (see previous chapter) within the project.

The collected information will flow from concerns to informal principles which will be measured on quality afterwards.

I started with reading literature about DIP. Literature on the DIP's website, (news) article's and all other kinds of public information. Beside this I studied internal documents about business processes, summary's of meeting to get a taste of the company culture.

I also made comparisons between DIP and DIPUSA to find hierarchy and collisions.

After broaden my knowledge about DIP I gained more information for finding principles through open interviews. These interviews flow from informal to formal, depending on the importunacy of the employees and their role in the project. Also some telephone interviews took place with people from DIPUSA and some other affiliates.

Principles

Doc-part	Definition
Name	Shared data (TOGAF Principle)
Description	Users have access to the data necessary to perform their duties; therefore, data is shared across organization.
Motivation	Users must get their information at all times in the organization.
Implication	This is one of three closely-related principles regarding data: data is an asset; data is shared; and data is easily accessible. The implication is that there is an education task to ensure that all organizations within the enterprise understand the relationship between value of data, sharing of data, and accessibility to data. To enable data sharing we must develop and abide by a common set of policies, procedures, and standards governing data management and access for both the short and the long term. For the short term, to preserve our significant investment in legacy systems, we must invest in software capable of migrating legacy system data into a shared data environment. We will also need to develop standard data models, data elements, and other metadata that defines this shared environment and develop a repository system for storing this metadata to make it accessible. For the long term, as legacy systems are replaced, we must adopt and enforce common data access policies and guidelines for new application developers to ensure that data in new applications remains available to the shared environment and that data in the shared environment can continue to be used by the new applications. For both the short term and the long term we must adopt common methods and tools for creating, maintaining, and accessing the data shared across the enterprise. Data sharing will require a significant cultural change. This principle of data sharing will continually "bump up against" the principle of data security. Under no circumstances will the data sharing principle cause confidential data to be compromised.

	Data made available for sharing will have to be relied upon by all users to execute their respective tasks. This will ensure that only the most accurate and timely data is relied upon for decision-making. Shared data will become the enterprise-wide "virtual single source" of data.
Assurance	The user will be measured about; of the users can perform their duties wherever in the organization. This will be done by questionnaires and interviews.

Doc-part	**Definition**
Name	Common communication channel
Description	The Internet is the common communication channel for information services
Motivation	Users can communicate through the Internet and get their information from here.
Implication	To enable the use of Internet for information services we must develop principles and policies for governing and applying information services. Network must be available throughout the whole organization with computers that will fit into Tools for creating, maintaining, and accessing the data shared across the enterprise. Adapt and enforce common acceptable policies See principle “Information security”
Assurance	By interviewing the users; they do always use the internet for communicating information instead, for example, USB sticks

Doc-part	Definition
Name	Maintainability
Description	The system can be maintained by a system administrator
Motivation	After the release of the system the extra costs must be reduced as much as possible in a way of maintainability
Implication	Maintainability is meant in software and hardware Physical access to the system should be arranged in policies The system must be composed of common parts The software should be open-source The software system must be easily maintainable and approachable There must be a back-up server The “Use of software” and “Edge programs” will advance this principle See principle “OO Programming”
Assurance	There is no need for an expert to maintain the system, employees (system administrators) can fully take care of the maintainability of the system.

Doc-part	Definition
Name	Delete information
Description	Deleted information will be moved.
Motivation	Participants and other information must always be stored (archives) for history, analysis and back-up.
Implication	Information must be back-upped Back-ups will always be stored and in a separate place Deleted information should be set inactive instead of been deleted

	The system does not allow to delete information but move this information to a back-up system Log all actions concerning delete / modify information including the specific data
Assurance	Delete information is not possible by any user; modified information should be logged including the new and old data

Doc-part	**Definition**
Name	Use of software (TOGAF Principle)
Description	The software is easy to use (understandable).
Motivation	Different people from different countries all over the world must be able to use the system.
Implication	Software and texts are in clear English Help functions are always available Users can always send direct feedback to a feedback system The system should be reviewed / tested by all kinds of people Software is easy adjustable to improve obscure in the system
Assurance	All participants and users can handle the system. This can be measured by questionnaires and interviews.

Doc-part	Definition
Name	Managed information
Description	Information is consistent
Motivation	Administrators should be aware of correctness, consistency and quality of information
Implication	Adapt and enforce policies for administrators Administrators should be aware of their actions (training) The system must reduce inconsistencies Fixed information (relation address, name) should be verified by a third party trough the internet (automate) Administrators must get reports of all changes made by non-administrators
Assurance	Information in consistent; this can be measured by query's and by user interviews

Doc-part	Definition
Name	Information Security
Description	Information across the organization through the common channel is secured.
Motivation	Unauthorized access to information from in- or outside the organization is protected.
Implication	Information is authorized Information is encrypted All data communication is logged See principle "Authorization" and "Software controls"
Assurance	Third-party test of stealing / changing information trough the common channel

Doc-part	Definition
Name	Edge programs
Description	Common edge programs are used.
Motivation	Edge software must be easy in use so inexperienced people can handle it (like familiar or quick learning software)
Implication	Most common software should be used Edge software guides and documentation will be available Edge programs are compatible with the software system
Assurance	Users can handle the edge programs; edge programs are widely used; this will be measured by questionnaires.

Doc-part	Definition
Name	Server protection
Description	The server and server room is physical fully protected.
Motivation	The server (and other hardware) may not be stolen, changed or destroyed
Implication	Authorization policies for the server room Firefighters must be able to enter the server room anytime Third parties cannot enter the server room without authorization Adapt and enforce policies for employees Offices will be locked when not-in-use Offices have an automatic door lock See principle “Maintainability”
Assurance	Unauthorized people cannot physically “touch” the server; this can be tested with an independent third-party

Doc-part	Definition
Name	OO Programming
Description	Programming is Object Oriented and foresee of comments
Motivation	The system must be programmed most efficiently so also other programmers can work with the program
Implication	Adapt and enforce programming policies for programmers The use of OO language is obliged Use of common programming languages The language must support the other requirements of the system
Assurance	Supervise and monitor the programmers and their managers

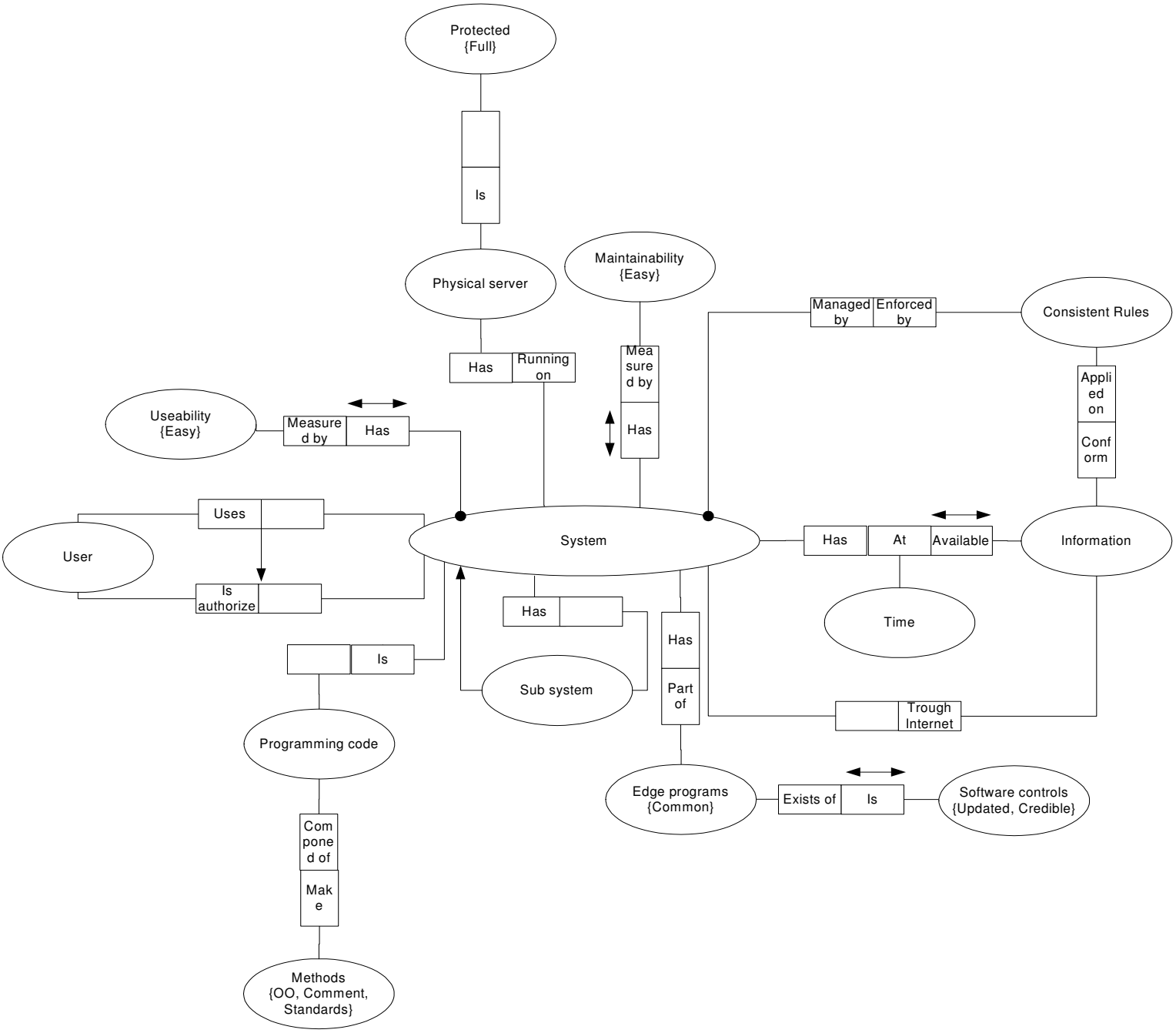
Doc-part	Definition
Name	Standardized features
Description	Use standardized features
Motivation	Programmers should use the most common programming language and functions
Implication	Standardized means familiar in common programming environments Make use of off-the-sell features See principle “OO Programming”
Assurance	Supervise and monitor programmers and their managers

Doc-part	Definition
Name	Authorization
Description	Each user should be authorized and aware for their actions
Motivation	Users should authorized to perform specific actions, their will be different levels of security and data security, confidentiality, integrity and availability
Implication	Adapt and enforce data information policy for every user

	Only grant access to the system after login Every user has a username and password Authorization can be specified to users and groups Users see their last login information Policy See for availability principle “Delete information” See for integrity principle “Managed information”
Assurance	All users must sign a policy; users always have to log on.

Doc-part	**Definition**
Name	Software controls
Description	Software control should always be credible and updated
Motivation	The system must be secured with the highest software controls.
Implication	Use of reliable and first-rate software controls Automate updates immediately when available The Software control server manages all computers
Assurance	Schedule updates and periodic manual checks

Domain model

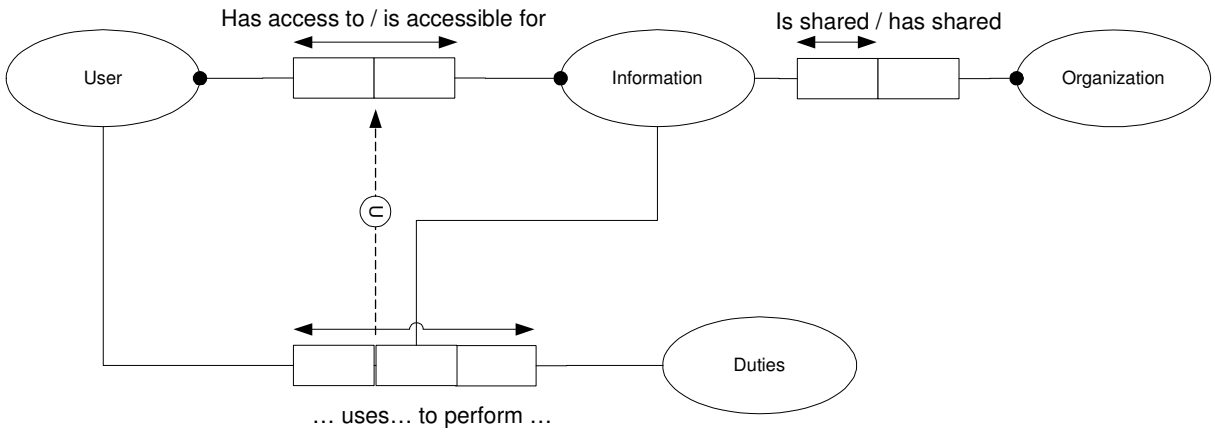


Formalization of principles

In the formalization of the architecture principles I used the following template derived from *Formalizing Architecture Principles using Object-Role Modeling* [FAP07].

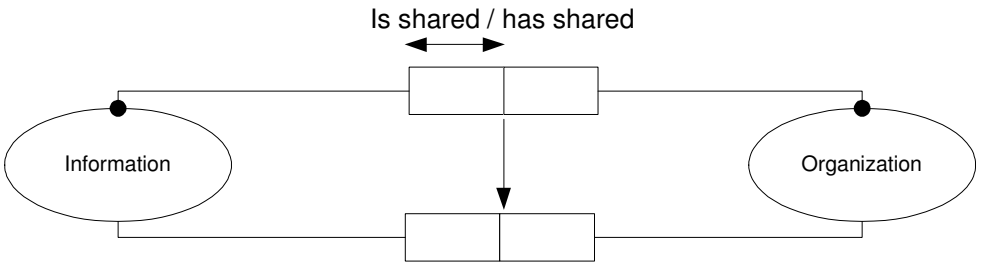
Doc-part	**Definition**
Statement	Brief, clear & precise/unambiguous statement of the principle. This is simply for reference; it shows what the fundamental rule is of the principle, in natural language.
Rationale	The original text of the rationale. This should show the reason behind the principle in the form of business benefits which are obtained by adhering to this principle. This is the rationale in the words of the architect, not the rationale of the person(s) who give(s) meaning to the architecture.
Assumptions	Here the assumptions made while interpreting the statement and rationale will be included in an ordered numerical list for easy (cross) reference. This is the rationale of those who give meaning to the architecture by interpreting it and extracting the meaning from the information.
ORM Schema	This is where the graphical ORM schema is inserted.
Verbalization	This is where we include the relevant verbalization of the fact types and entity types. This shows in a semi-formalized natural language what the structure of the schema is meant to represent by means of NORMA generated sentences.

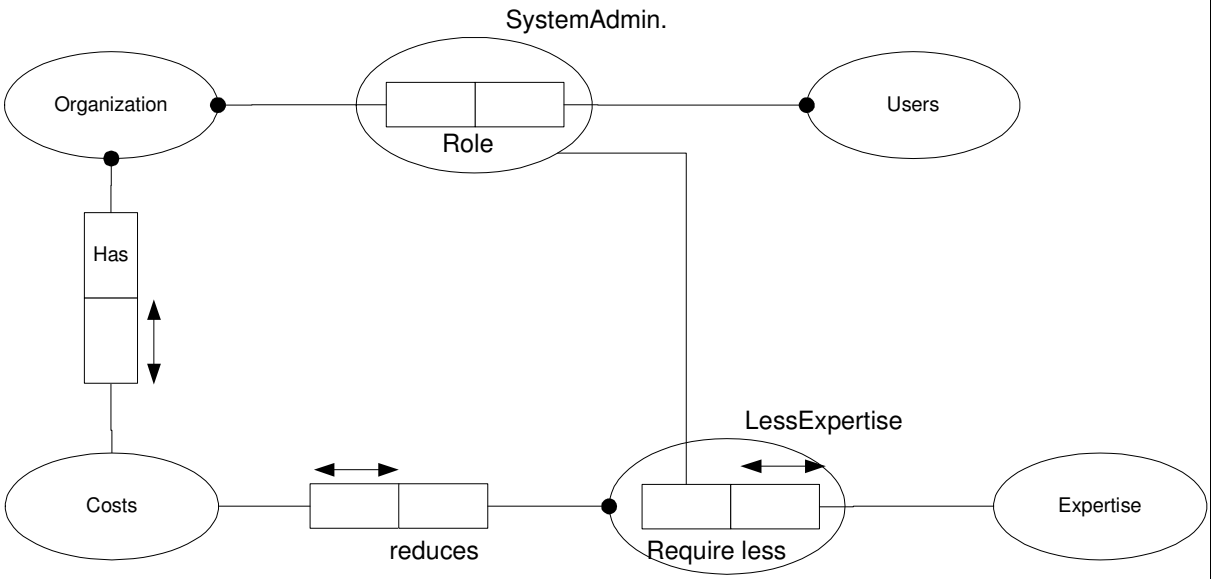
Issues	Issues that need to be solved in making the formalization of the principle specific enough to make it imposable.

Doc-part	**Definition**
Statement	Users have access to the data necessary to perform their duties; therefore, data is shared across organization. (TOGAF)
Rationale	Users must get their information at all times in the organization.
Assumptions	A1: User has access to the information A2: Common channel is available
ORM Schema	
Verbalization	**User** *has access to* **Information.** It is possible that more than one **User** *has access to* the same **Information** and that more than one **Information** *is accessible for* the same **User** Each **User** *has access to* some **Information.** Each **Information** *is accessible for* some **User.** Each **User**, **Information** combination occurs at most once in the population of **User** *has access to* **Information**.

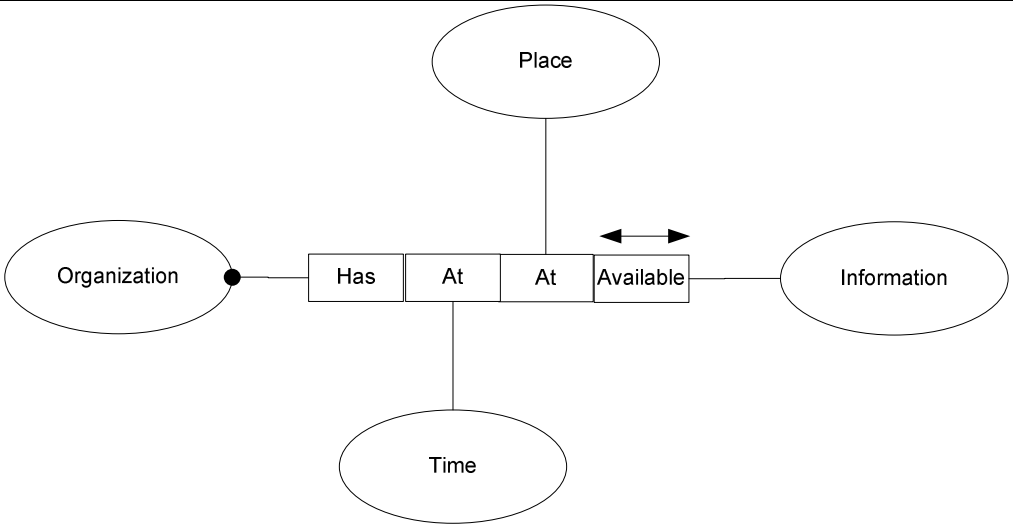
	Information *is shared* in the **Organization**. **Organization** *has shared* **Information**. Each **Information** *is shared* in at most one **Organization** **User** *uses* **Information** *to perform* **Duties**. It is possible that more than one **User** *uses* the same **Information** *to perform* the same **Duties** and that the same **User** *uses* more than one **Information** *to perform* the same **Duties** and that the same **User** *uses* the same **Information** *to perform* more than one **Duties**. Each **User**, **Information**, **Duties** combination occurs at most once in the population of **User** *uses* **Information** *to perform* **Duties**. **User**, **Information**, **Duties** combination occurs at most once in the population of **User** *uses* **Information** *to perform* **Duties.**
Issues	Information will only be accessible though the common Internet Channel

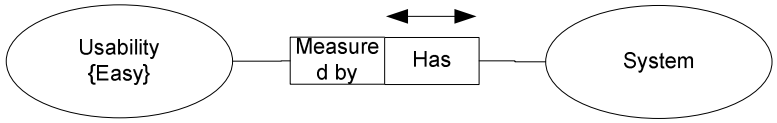
Doc-part	**Definition**
Statement	The Internet is the common communication channel for information services
Rationale	Users can communicate through the Internet and get their information from here
Assumptions	A1: User has access to the information

ORM Schema	 Transfer over Internet / Internet communicating
Verbalization	**Information** *is shared* in the **Organization**. **Organization** *has shared* **Information**. Each **Information** *is shared in* at least one **Organization.** Each **Information** *is shared* in at most one **Organization** Each **Organization** *has shared* **Information**. Each **Information** *is shared* in the **Organization** must also (only?) *transfer over Internet* in the **Organization.** **Information** *transfer over Internet* in the **Organization** **Organization** *Internet communicating* **Information**
Issues	

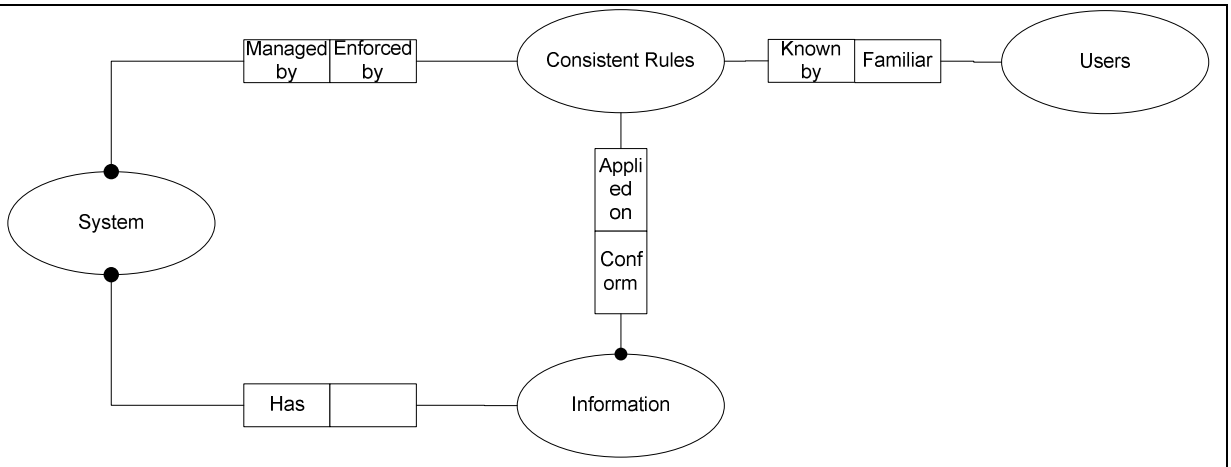
Doc-part	Definition
Statement	The system can be maintained by a system administrator
Rationale	After the release of the system the extra costs must be reduced as much as possible in a way of maintainability
Assumptions	A1: The system is accessible
ORM Schema	
Verbalization	**Organization** *has* **Cost**. Each **Organization** *has* at least one **Cost**. Each **Cost** *has* at most one **Organization** . *It is possible that the same **Organization** *has* more than one **Cost**. **LessExpertise** *reduces* **Cost**. Each **Cost** *reduces* at most one **LessExpertise** Each **LessExpertise** *reduces* at least one **Cost**. *It is possible that the same **LessExpertise** *reduces* more than one **Cost**. **Organization** *role* **Users**. Each **Organization** *role* at least one **Users**.

	For each **Users**, exactly one **Enterprise** *role* that **Users**. *It is possible that the sam**e Organization** *role* **more** than one **Users**. **SystemAdmin** *requires less* **Expertise**. For each **Expertise**, at most one **SystemAdmin** *requires less* that **Expertise**. *It is possible that the same **SystemAdmin** *requires less* more than one **Expertise**.
Issues	I1: The system administrator has to be certified

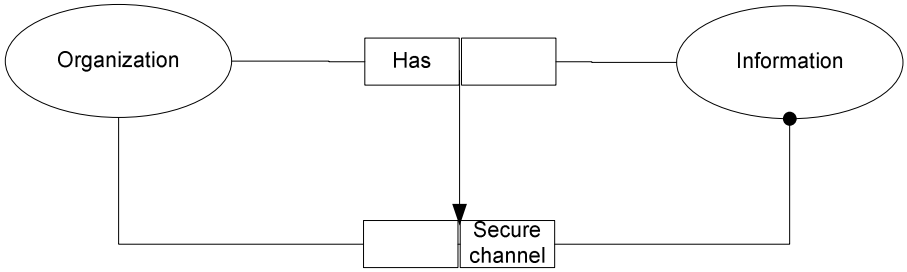
Doc-part	**Definition**
Statement	Deleted information will be moved.
Rationale	Participants and other information must always be stored (archived) for history, analysis and back-up.
Assumptions	A1: Enough disk space is available
ORM Schema	
Verbalization	**Organization** *at* **Time** *at* **Place** *has* **Information** **Organization** *has at* **Time** *at* **Place** *available* at least one **Information** **Information** *at* **Place** *at* **Time** *available* **Organization** **Information** *at* **Place** *at* **Time** *available* at most one **Organization**
Issues	I1: Information about *who/what/when* changing information have to be logged

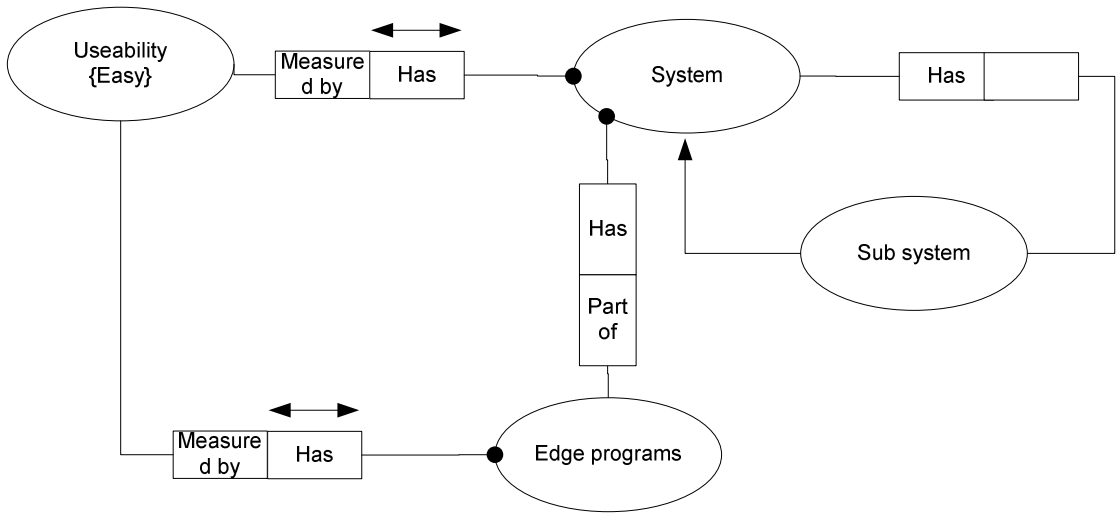
Doc-part	Definition
Statement	The software is easy to use (understandable).
Rationale	Different people from different countries all over the world must be able to use the system.
Assumptions	A1: Software is English or multi-language
ORM Schema	
Verbalization	**Usability** *measured by* **System** **System** *has* **Usability** **System** *has* at most one **Usability** **Usability** must be set to ***easy***
Issues	I1: What is *easy to use* for a non-computer user?

Doc-part	Definition
Statement	Information is consistent
Rationale	Administrators should be aware of correctness, consistency and quality of information
Assumptions	A1: The consistency rules will catch all consistency's

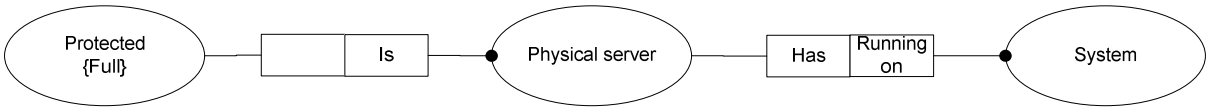
ORM Schema	
Verbalization	**System** *measured by* **Consistent rules** **System** has at least one **Consistent rules** **Consistent rules** *enforced by* **System** **System** *has* **Information** **System** has at least one **Information** **Information** *has* **System** **Consistent rules** *known by* **Users** **Users** *familiar* **Consistent rules** **Consistent rules** *applied on* **Information** **Information** *conform* **Consistent rules** **Information** has at least one **Consistent rules**
Issues	

Doc-part	**Definition**
Statement	Information across the organization through the common channel is secured.
Rationale	Unauthorized access to information from in- or outside the organization is

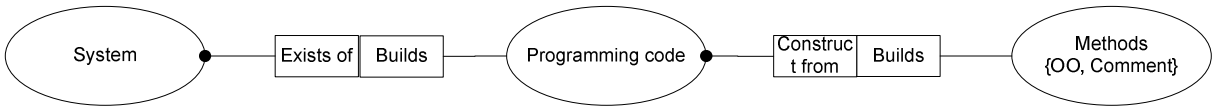
	protected.
Assumptions	
ORM Schema	
Verbalization	**Organization** *has* **Information** **Information** *secure channel* **Organization** **Information** has at least one **Organization** Each **Information** in the **Organization** must also *secure channel* **Organization**
Issues	I1: The secure channel is not applied on physical flows.

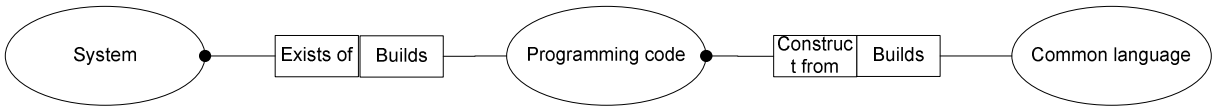
Doc-part	Definition
Statement	Common edge programs are used.
Rationale	Edge software must be easy in use so inexperienced people can handle it (like familiar or quick learning software)
Assumptions	
ORM Schema	
Verbalization	**Usability** must be set to *Easy* **Usability** *measured by* **System** **System** *has* **Usability** **System** has at least one **Usability** **System** has at most one **Usability** **Usability** *measured by* **Edge programs** **Edge programs** *has* **Usability** **Edge programs** has at least one **Usability**

	Edge programs has at most one **Usability** **System** *has* **Edge programs** **System** has at least one **Edge programs** **Edge programs** *part of* **System** **System** *has* **Sub system** **Sub system** is a **System**
Issues	I1: What about a non-computer user?

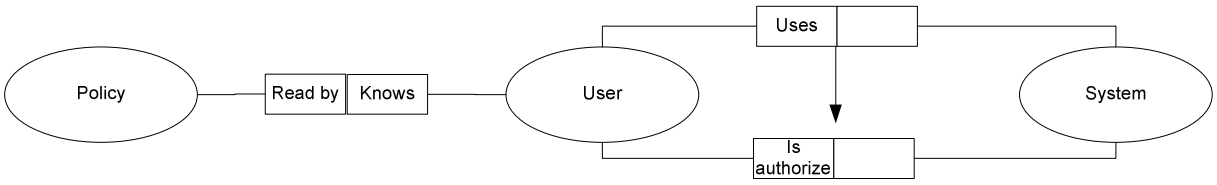
Doc-part	**Definition**
Statement	The server and server room is physical fully protected.
Rationale	The server (and other hardware) may not be stolen, changed or destroyed
Assumptions	
ORM Schema	
Verbalization	**Protected** must be set to *Full* **Protected** *is* **Physical server** **Physical server** *is* **Protected** **Physical server** is at least one **Protected** **Physical server** *has* **System**

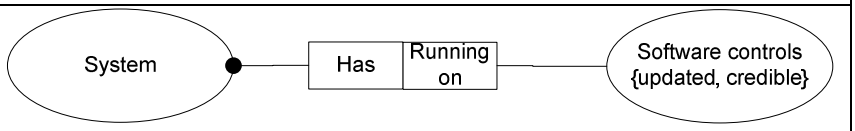
	System *running on* **Physical server** **System** has at least one **Physical server**
Issues	

Doc-part	**Definition**
Statement	Programming is Object Oriented and foresee of comments
Rationale	The system must be programmed most efficiently so also other programmers can work with the program
Assumptions	
ORM Schema	
Verbalization	**System** *exists of* **Programming code** **System** has at least one **Programming code** **Programming code** *builds* **System** **Programming code** *construct from* **Methods** **Methods** *builds* **Programming code** **Methods** must be set to *OO* and *Comment*
Issues	

Doc-part	Definition
Statement	Use standardized features
Rationale	Programmers should use the most common programming language and functions
Assumptions	
ORM Schema	
Verbalization	**System** *exists of* **Programming code** **System** has at least one **Programming code** **Programming code** *builds* **System** **Programming code** *construct from* **Common language** **Common language** *builds* **Programming code**
Issues	

Doc-part	Definition
Statement	Every users should be authorized and aware for their actions
Rationale	Users should authorized to perform specific actions, there will be different levels of security and data security, confidentiality, integrity and availability
Assumptions	

ORM Schema	
Verbalization	**Policy** *read by* **User** **User** *knows* **Policy** **User** *uses* **System** **User** *is authorized to use* **System** Each **Users** who *uses* **System** must also be *authorized* by **System**
Issues	

Doc-part	**Definition**
Statement	Software control should always be credible and updated
Rationale	The system must be secured with the highest software controls.
Assumptions	
ORM Schema	
Verbalization	**System** *has* **Software controls** **System** has at least one **Software control**

	Software controls *running on* **System** **Software controls** must be set to *Updated* and *credible*
Issues	

Framework

Below you see the framework constructed during my research and while working with the specific approach from the Principle Arena. The framework contain 13 steps. Each step tells you *what* to be done, *how* it should be done, the *process* to carry it out and the *product* it will deliver. In the next framework we will see how to measure the quality.

Step	What?	How?	Process	Product
1	Agree on the scope	Facilitator states the scope and checks if all participants acknowledge this scope.	Gather anonymous	Enclosed scope
2	Formulation of concerns	Identify concerns of the stakeholders, based on their role and personal interests.	Gather anonymous	Concerns must have exactly one core, and must have one or more motivations
		Group & filter concerns	Chaired by facilitator	Set of grouped (and aggregated) concerns, and a list of `spillover' candidate principles/guidelines
		Limit list to the highest priority concerns	Chaired by facilitator	List of high priority concerns
		Check consensus and perform a self-check		
3	Formulation of candidate principles	Gather draft principles. See criteria's of the openGroup and make use of the Integrated Architecture Framework to describe the principles	Gather anonymous	Draft principles must have a core, must address at least one of the selected concerns. This addressing must have one or more motivations.
		Group and filter draft principles(no spillovers)	Chaired by facilitator	Set of grouped (and aggregated) principles, and a list of spillover candidate guidelines (natural language)
		Identify intended implications	For each principle: (1) gather anonymously positive and negative examples/effects, and (2) group these chaired by the facilitator	For each principle positive and negative examples of effects, positioned in terms of an enterprise engineering framework.
		Check consensus		

Step	What?	How?	Process	Product
4	Produce domain model	Produce a domain model in ORM of the concepts underlying the principles thus far, and re-formulate the principles as rules in terms of this domain model.	Using parsing techniques a list of terms used in the formulation of the principles can be created. For each of the terms in this list a definition should be provided	ORM domain model where the domain experts should have the mandate to make decisions about the domain's interpretation
		Check model with Krogstie Quality Framework	physical-, empirical-, syntactic-, semantic-, pragmatic-, social- and organizational quality	Correct ORM domain model
5	Formalize principles	Reformulate the candidate principles in terms of ORC expressions over the domain model	If interpretation issues arise, one may have to resort to the formulation of alternative formalizations	This may lead to refinements of the domain model
		Check models with Krogstie Quality Framework	physical-, empirical-, syntactic-, semantic-, pragmatic-quality	Correct ORM models, and domain model
6	Do a consistency check	Given the domain model and the set of ORC formulations of the principles, a consistency check can be performed	A theorem prover can be used to support in this task	Refinements in the domain model as well as the formalization of the principles
7	Evaluate longevity and completeness of candidate principles	Identify different realistic scenario's for the future of the enterprise, and identify possible unwanted effects (and counter measures) of the principles and/or unwanted effects not covered by the principles formulated so-far.		Evaluate completeness of set of principles
8	Validate and resolve domain model	Let the facilitator do a ``pop-quiz'' about each term's meaning		

Step	What?	How?	Process	Product
9	Validate candidate principles and chose between alternatives	Validate the formalization of the candidate principles, and where alternative formalizations are given, select one interpretation.		
10	Prioritize candidate principles		For each grouped principle, weigh their contribution to the concerns	Prioritized list of principles based on their contribution to the concerns. Note: Allow for `manual override' in this list.
11	Define measuring mechanisms	Given the selected set of principles, determine which fact types in the domain model which have been marked as needing a definition for measuring	For each of these fact types define a measuring mechanism which is in line with the principles (and underlying concerns) which refer to the fact type.	
12	Define implementation measures	For each of the selected principles, and associated measuring mechanisms, define how this principle will be implemented in the system engineering community	Use the educate, engineer and enforce distinction	Refinement of the measuring mechanisms defined in the previous step.
13	Cost / benefits	Make a costs / benefits model to see the overall results		

The previous framework tells you the *way of working*. The next framework will verify your way of working in each step. This is done with several aspects in each step:

Step	What?	Product	*Intrinsic*	*Contextual*	*Representational*	*Accessibility*	*Emphasis*	*Krogstie*	*Time indication %*	*Related to*
1	Agree on the scope	Enclosed scope	X	X			C		5	
2	Formulation of concerns	Concerns must have exactly one core, and must have one or more motivations	X	X	X	X	B		20	
		Set of grouped (and aggregated) concerns, and a list of `spillover' candidate principles/guidelines				X				
		List of high priority concerns	X							
3	Formulation of candidate principles	Draft principles must have a core, must address at least one of the selected concerns. This addressing must have one or more motivations.	X	X	X	X	B		15	
		Set of grouped (and aggregated) principles, and a list of spillover candidate guidelines (natural language)	X							
		For each principle positive and negative examples of effects, positioned in terms of an enterprise engineering framework.	X	X	X	X				
4	Produce domain model	ORM domain model where the domain experts should have the mandate to make decisions about the domain's interpretation	X	X	X		CB	X	5	
		Correct ORM domain model	X	X	X	X				
5	Formalize principles	This may lead to refinements of the domain model	X	X			CB	X	10	
		Correct ORM models, and domain model	X	X		X				
6	Do a consistency check	Refinements in the domain model as well as the formalization of the principles	X	X	X	X	C	X	5	3
7	Evaluate longevity and completeness of candidate principles	Evaluate completeness of set of principles	X	X	X		B		5	
8	Validate and resolve domain model		X	X	X	X	CB	X	10	4
9	Validate candidate principles and		X	X	X	X	B		5	3

	chose between alternatives									
10	Prioritize candidate principles	Prioritized list of principles based on their contribution to the concerns. Note: Allow for `manual override' in this list.	X			X	B		5	
11	Define measuring mechanisms		X	X	X	X	CB		10	
12	Define implementation measures	Refinement of the measuring mechanisms defined in the previous step.	X	X	X	X	B		5	
13	Cost / benefits		X	X	X	X			5	

Summary and conclusion

Evaluation

"How to formulate principles in an effective way?"

The research question to answer the problem definition are

- *Is the specific approach clear and feasible?*
  - Are the steps clear and unambiguous?
  - Is my interpretation also the same as the intention?

First of all the applied method was new and never been practiced therefore sometimes it was hard to make decision but on the other side there was a lot of openness for free interpretation.

The first stage of the method is aimed on collecting information for formulating principles. Because these principles are the basis and I had not much experience with colleting principles it was difficult and time consuming for me to get the real principles above. I had to explore the organization to understand the essence for formulating good and unambiguous principles. After a short time I realized that words like *good, easy* and *professional* are not on the right place in a principle. I had to get the real meaning behind these words which was kind a difficult because each stakeholder had different conceptions and different interpretations of words like these. Now I see the misunderstanding and why a project can *fail* because of these "little" things. Also, in the beginning, I gave my own interpretation instead of really trying to understand the stakeholder. Especially in a different culture where time and openness is less than Europe it was a big mistake.

After all the principles were clear I had to produce a domain model of the concepts underlying the principles. This was one of the hardest stage. It was unclear what the method exactly expected from this domain model. Also the inconsistency and problems about the principles came up. This improved the principles (and thus the domain model) time after time what make this stage very powerful. The domain model is written in ORM so the natural language of the principles could be graphically

reflected including their constraints. The next step of formalizing principles still brought changes to the domain model. A detailed look of a principle brought new perspectives and solutions for the entire domain model.

- *Are the principles consistent and unambiguous?*
    - Does the set of principles have contradictory's?
    - Is the set of principles understood by each stakeholder?

Before the formalization I tried to solve all inconsistency's and contradictory's. I found some and thought that all were solved. In the formalization stage it turned out there were a quiet few contradictory's and some inconsistency's. While constructing the domain model and see the principles related to each other the contradictory's arises. In the domain model almost every problem came up. From language issue till contradictory's. This step is a huge improvement to the set of principles and also the comprehensibility. In the ORC formalization of the principles little issues came up about not entirely covered problems.

Before introducing the improved principles and the domain model to the stakeholders I had to get the stakeholders familiar with the ORM language (a short introduction). This was a time consuming task because of the many asked questions. I will advise to spread a handout to all stakeholders. But when the language was clear the stakeholders are more commit to each other and some good specific questions were asked to improve the model and principles.

Finally when showing the domain model and the principles to the important stakeholder individually there was shared commitment and harmony.

- *How will effectiveness be measured?*
    - Are the formalized principles comply with Krogstie's Quality Framework?
    - Cost / benefits?

Each principle and the domain model satisfies to the quality framework. This doesn't means that *it is* effective but we can say it meets the quality standards. The relation between costs and benefits are still responsible for the effectiveness because the costs may (usually) never exceed the benefits. The next question will answer explain the made costs and the benefits.

- *How are the costs relating to the benefits?*
    - What are the affected costs?
    - What are the benefits?
    - How is this measured?

Costs

With costs I mean the time I spent, the stakeholders and other people and the used materials, all related to the project. My time includes research, reading literature, verifying, preparations, interviews and presentations. The time with the stakeholder is in terms of preparation, interviews, discussions, conclusions and getting familiar afterwards. Other people are my supervisor and people who helped me without being involved in the project.

Week	What?	My costs	Other costs	Materials
1, 2	Gather information	20	5	2
3, 4, 5	Interviewing	30	15	6
6, 7	Formulation	20	2	3
8, 9	Domain model	20	5	1
10,11, 12	Formalization	30	2	1
13, 14	Validation, improvements	20	6	16
15 >	Implementation	0	20 >	?
Total		140	55	29
Factor		0	4.2	1
Total		0	231	29

The above table represents the made hours by people involved in the project. This represent the hours but not the exactly costs therefore you also see a factor representing the costs. This factor is depended on the stakeholder involved. The factor is composed from a valued average of all the stakeholders. My factor is zero because I was not an expense in the project but in a normal project these costs will also count. The material factor is one, the calculation is based on a balance between the costs in hours and materials.

Benefits

The benefits are measured four months afterwards though telephone. D.I.P. is now constructing the information system are using the principles. The unilateral agreement between the stakeholders is still intact and the principles are not changed since. This indicates that the principles are really come from the concerns of the stakeholders. Some principles could not be applied yet, as example that the system can be maintained by a system administrator and that the software is easy to use. For now we can say that the principles had their benefits especially there is harmony between the stakeholders.

- *Is the set of principles compliant to?*
    - What did D.I.P. do with the principles?
    - Why did or did not D.I.P. adapt the set of principles?

As stated above D.I.P. is constructing the new information system with the underlying principles. The main reason for adapting the principles is the harmony and the univocally of the principles. This leaded to fully agreement and understandability. They are really satisfied about the set of principles and see whole new perspectives. The costs they had to make are so little that, they say, it's almost not important. About the principle *The server and server room is physical fully protected* was some disagreement afterwards. Some stakeholders believed that this principle was not under their control and in their range because it was the responsibility of a third party. Other stakeholders disagreed with this and found they were self-responsible for the third party they have chosen. For me this was quite remarkable because there *was* total agreement. A stakeholder can never have full control about everything but in this case security and data-loss are so important some stakeholders could not believe that this principle is good enough for securing their system by a third party.

Future research

Enterprise architecture is a wide, complex growing field of study. Different people with different perspectives have their own vision on enterprise architecture and therefore it will change continues. We can say enterprise architecture is immature but fast developing in the last years. But there has to be a lot of researches and practices to be done. The focus on principles is an important issue in enterprise architecture. Because of the impact of principles in an enterprise architecture it is not the question of principles belong to enterprise architecture but **when** there is full agreement. In this thesis we did an experiment with one approach to formulate and formalize principles and look at the effect of these. This approach is extended with an improved framework and a way to measure the effectiveness. Future research have to carried out in terms of experiments with the new framework. In this workshop the method is applied in the United States but the way of working and the results will be probable different. Other research can be done in different ways to gather, formulate and implement principles.

Feedback

The way of collecting information is not mentioned in the method which is not an issue. The *architect* is fully responsible for this stage. The architect should become *one* with the organization to understand its mission, vision and strategy. This can be done in several ways which, now, the method leaves open for any interpretation. To be a step ahead it could be good to evaluate (a self-check) the architect of its knowledge and views about the organization. This can be very helpful by formulating the principles. The architect would better understand the stakeholders and in that way he can ask more related questions.

It's the architect responsibility that the principles are good. The Open Group has five criteria's that distinguish a good set of principles (see *Principles*). With these criteria's the architect can check and validate the formulated principles. The method can refer to these (or other) criteria's so the architect is inclined to validate the principles by means of criteria's. Also a way to describe principles like the Integrated Architecture Framework [IAFv3] can be referred in the method.

Formalizing principles in ORM is a good way to do. ORM can handle principles and is readable for *all* users. Because of principles are more like business rules it could be better to use a business rule tool. A business rule tool can help the architect to formalize a consistent set of principles. Business rule tools have been available for a number of years and they vary widely in terms of functionality. It's important that a chosen tool fits this method properly. A business rule tool can help the architect from the formulating principles stage what replaces the methods used in this case.

For the whole process it should be good that stages are time-tied. Not in terms of actual periods but more in percentages. So the architect has a better time insight for all stages. Also the method will fit better in an entire project with hard deadlines.

Before the new framework will be practiced in a real life case it could be helpful to represent the method in a short ideal test case. In a test case little issues can be corrected and it can be used as an example for the real life case. By obscurities the architect can refer to an example of an ideal situation. The framework have to be improved by best practices and practical experiences.

Experimental feedback

The workshop I carried out was to apply a new approach for formulating and formalizing principles. Because it was the first time this approach was tested in a real-life it was kind of an experiment. So we applied an experiment in an experimental environment. This was new for me and very instructive. The beginning was very hectic and sometimes unprofessional. I was not really prepared and because of this it was hard working in the beginning. In this scenario it was not possible to prepare myself; the next time I will advise to do a good preparation, on the experiment you will apply and the environment where you will apply.

Reflection

When I look back on the whole process, it was a learn full path; finding principles in a different culture, the formalization of these, writing this thesis but also the experience to go abroad, staying with host families and everything together. The process of getting familiar in a new environment while applying a new approach with collecting information only based on theoretical practices was sometimes hard but overall very learn full. Now I have experiences in getting the real principles above and see what the influence is in early made mistakes / miscommunications. Writing a thesis was also a separate topic. The very clear step-by-step structure, the underlying thoughts by founded research and the scientific way of working with less scientific (no maths) topics.

Overall I learned how to integrate in an unfamiliar environment, collecting information and from there getting the real principles above guided by an untried approach, working with principles in terms of formalization and given my opinion and feedback about this process for further research.

References

[ARCH] http://www.archimate.org/

[BOM06] Bommel van, P. Hoppenbrouwers, S.J.B.A. Proper, H.A. Weide van der, Th.P. Giving Meaning to Enterprise Architectures, Institute for Computing and Information Sciences, Radboud University Nijmegen, 2006

[DQ96] Wang, Richard. Y. Strong, Diane M. Beyond accuracy: What data quality means to data consumers?, Journal of management Information Systems, Spring 1996

[FAP07] Chorus, G.J.N.M. Janse, Y.H.C. Nellen, C.J.P. Hoppenbrouwers, S.J.B.A. Proper, H.A. Formalizing Architecture Principles using Object-Role Modeling, Institute for Computing and Information Sciences, Radboud University Nijmegen, 2007

[IAFv3] Capgemini, The Integrated Architecture Framework

[IEEE] Recommended Practice for Architectural Description of Software Intensive Systems, Technical Report IEEE P1471-2000, The Architecture Working Group of the Software Engineering Committee, Standards Department, IEEE, Piscataway, New Jersey, USA, September 2000

[IRIS] Institute for Computing and Information Sciences, Radboud University Nijmegen, http://www.cs.ru.nl/iris

[KROG03] Krogstie, John, Evaluating UML Using a Generic Quality Framework, Idea Group Inc, 2003

[PA07] Proper, H.A. Tools for Enterprise Engineering, Principles Arena, Institute for Computing and Information Sciences, Radboud University, 2007, http://www.cs.ru.nl/tee/projects-pa.htm

[TEE07] Proper, H.A. Tools for Enterprise Engineering, Institute for Computing and Information Sciences, Radboud University Nijmegen, 2007

http://www.cs.ru.nl/tee/

[TOGAF] The Open Group Architecture Framework,

http://www.togaf.org/