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# Argumentative Design
# – towards further grounding in Design Rationale

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*VITS working paper*

***Abstract***

The complexity of information systems (IS) design is well acknowledged. There may exist many design issues and each issue can be resolved in different ways which implies the existence of many different design alternatives. The system's roles and functions in the workpractice may comprise many complex design considerations. There may also exist many complex design considerations concerning the human-system interaction. Several approaches exist with focus on how to conceptualise and visualise design options and their possible advantages and disadvantages. Under the label of Design Rationale (DR) several different approaches have been presented and used in IS design. DR emanated from the works by Horst Rittel on wicked problems and issue-based information systems.

Design Rationale involves 1) a basic conceptualisation (through concepts like issues, positions and arguments), 2) notations (diagrams visualising patterns of issues, positions and arguments) and also computer tools for the support of the design process. A key idea behind DR is to make the pro and contra arguments concerning different design alternatives explicit. This is a way to expand the design space and to bring more rationality to design decisions. The grounds for choosing a design alternative should be explicit through different criteria. But how are different criteria grounded?

This paper explores the Design Rationale approach. It presents a revised approach (Argumentative Design) where arguments are structured in more nuanced ways. The notion of Criteria in DR is differentiated into criteria and consequences. The diagrams describing alternatives and arguments are supplemented by a matrix clarifying alternatives, criteria and consequences, where ranking of alternatives are made explicit. Further grounding is made through explicit goal analysis and problem analysis. The used criteria are justified and ranked through goal analysis. The design issues are grounded through problem analysis since the issues and alternatives are seen as responses to certain problems. The Argumentative Design approach will give a more elaborated grounding of design decisions.

The extended Argumentative Design approach is illustrated through the use of a case study. The example is from an interaction design of a municipal e-service for application of food permits.

## 1 Introduction

The design of user interfaces as well as other aspects of information systems (IS) involves many challenging and complex issues. IS design is not just an issue of technical design. It involves also the consideration of how humans (as users) will interact with the technical artefact. It involves the structuring of information and communication (concerning both user interfaces and data bases) and how this will be part of a future workpractice. The design of IS can be said to encounter what is called *wicked problems* (Rittel, 1972; Rittel & Webber, 1973; Conklin, 2006). Such problems are complex in fundamental ways. The problematic situation and its possible resolutions are wicked. There is not any immediate solution to a wicked problem. According to Rittel (ibid) a wicked problem and solution situation can comprise the following characteristics:

- There will not exist an exhaustive definition of the problems
- Described problems can be seen as symptoms of other wicked problems
- Problems can be explained and diagnosed in many different ways; none will be the correct one
- Such problem and solution situations have unique and often novel features
- There does not exist any right or optimal solution, only satisfying solutions
- There are difficulties to understand the problems until solutions are formulated and even tried out
- There may exist many possible solutions; too many to be described in any exhaustive way
- Many solutions may have unforeseen consequences

Another way to put it is to emphasise the inherent *cognitive complexity* of wicked problems. This means that such a situation involves:

- Many sub-problems
- Intricate problem relations
- Difficulties to perceive and comprehend the total problem situation
- The existence of vicious circles
- No self-evident solution options
- Solutions that need to be well fitted to situational demands
- Risks that new solutions will introduce new problems

Such situations do not only comprise cognitive complexity. They may also comprise *social complexity* (Conklin, 2006). This is due to the fact that there are *many stakeholders* who are affected by the problems and also by the possible solutions. Stakeholders can belong to different organisations or organisational sub-units. This means that they can be governed by different goals and interests. Different stakeholders can occupy different professions, which imply variations in background, preferences and professional languages. Affected people are not only representatives of defined stakeholders; they are persons with variations in personal traits (personality, rationality, communicative ability, experiences). Different stakeholders may define problems in different ways and also conceive different situations as problematic or non-problematic. There will among different stakeholders exist variations in goals and objectives and how these are prioritized.

Cognitive and social complexity coincide often in IS design. This makes it a great challenge to organize and perform the design of information systems. There exist of course many methods and cooperation principles for IS development. This paper addresses a specific group of approaches which explicitly build on the conceptualisation of wicked problems as

described above. This group of approaches tries to integrate the design of an artefact (like IS) with the explication of the arguments concerning this design. This type of approach is often called Design Rationale (DR). Design Rationale is defined as "a representation for explicitly documenting the reasoning and argumentation that make sense of a specific artifact" (MacLean et al, 1991 p 203). There are several DR approaches; e.g IBIS (Conklin & Begeman, 1988; Conklin 2006), QOC (MacLean et al, 1991) and DRL (Lee & Lai, 1991). Most of them are quite similar although they differ somewhat in terminology. The core of these approaches is to describe 1) a design issue together with 2) design alternatives and 3) arguments of pro and contra character. We will introduce DR more fully and describe some DR approaches briefly in section 3 below.

Design Rationale can be used in HCI design but also for many other design issues, not only limited to IS design. Its recognition in HCI design (e.g. Carroll & Moran, 1991) is probably due to the cognitive and social complexity in such design. For example Conklin (2006) argues for a much broader application of the DR approach IBIS.

DR has its basis in design and problem solving theory (Rittel, 1972). Although this basis, there seems to be an unexplored potential of further theoretical and conceptual development of DR related to problem solving. DR does not seem to have been integrated with other design methods; but remains as a "stand-alone approach". There have been terminological and conceptual controversies during the history of DR; see section 3.2 below. These do not seem to be resolved yet. Buckingham Shum & Hammond (1994) conclude in their review of DR: "In conclusion, argumentation-based DR has been shown to be resting on rather more unstable conceptual and historical foundations than is often assumed by proponents of such approaches" (ibid p 645). This paper will address some conceptual and methodological problems of DR and propose further development. It takes the core of DR that is to be explicit concerning design arguments. The presented approach is called Argumentative Design and it follows ideas put forth in Goldkuhl (1991) and Holmgren et al (1992).

## 2 Research approach

### *2.1 Design research*

The research approach applied can be characterised as *design research*. It is a combination of *conceptual* and *empirical* research. 1) We have performed a critical conceptual analysis of Design Rationale and made a further conceptual and methodological development. 2) We have also used this revised DR approach (labelled Argumentative Design) in a design endeavour. This empirical part of our research consist of design of public e-services; specifically an e-service application for food permit in a municipal setting. This empirical example will be introduced in section 2.2 below and is used in section 4 as an illustration of our revised DR approach Argumentative Design. Our research approach is visualised in figure 2.1.

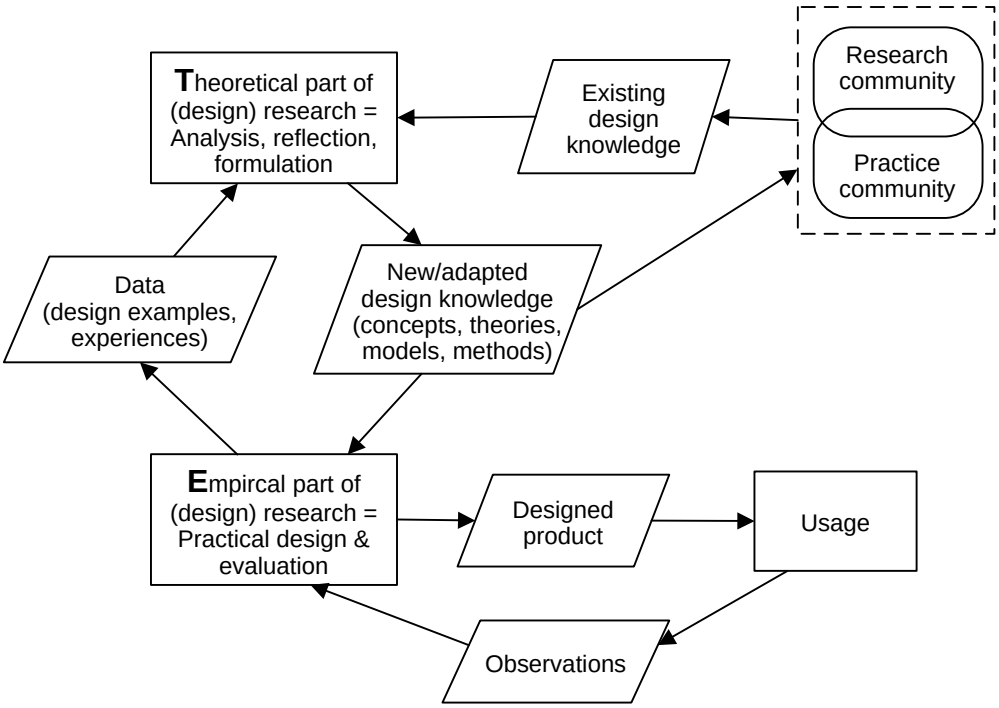


*Figure 2.1 Research approach: Design research*

The research has been a continual interplay between theoretical-conceptual work (T) and practical-empirical design work (E). The T-part has consisted of conceptual analysis of DR and development of a new DR-approach (Argumentative Design). The E-part has been conduct of a design project concerning public e-services. Part of this design project has been application of Argumentative Design.

Design research has emerged as vital research approach within information systems (e.g. Walls et al, 1992; Hevner et al, 2004; Gregor & Jones, 2007). Design research comprises practical design of artefacts. It also includes the development of what we here call *abstracted design knowledge*. Hevner et al (2004) have specified the following contributions from design research: Constructs, models, methods, and instantiations. Unfortunately they do not distinguish clearly between abstracted (general) knowledge (T) and situational and empirical knowledge (E). In their terminology, 'instantiations' are the designed artefacts aimed for practical usage in particular situations. Constructs and methods are general knowledge aimed to be used in different design situations. In their terminology 'models' seem to be restricted to situational knowledge[1]. However, there might be both situational models and abstracted (generic) models (Goldkuhl & Röstlinger, 2007). There is thus a restricted view on abstract results from design research in Hevner at al (2004). A more articulated view on abstract results from design research is presented by scholars like Walls et al (1992) and Gregor & Jones (2007) through the notion of *design theory*. This means that abstracted design knowledge are systematized in a particular way; in the form of a design theory. One purpose of a design theory is to govern concrete design endeavours. A generic model may be part of a design theory (Goldkuhl & Röstlinger, 2007).

[1] Confer the quote "Models use constructs to represent a real world situation – the design problem and its solution space …. Models aid problem and solution understanding and frequently represent the connection between problem and solution components enabling exploration of the effects of design decisions and changes in the real world." (Hevner et al, 2004 p 78-79).

This means that design research can involve design on two knowledge levels (E and T). It comprises of course concrete design of artefacts (as a kind of empirical research) – the E level. But it also comprises the development (i.e. design) of abstracted design knowledge (like constructs/concepts, design theories and generic models) – the T level.

The T-arena can involve (as in this case) an adaptation of existing design knowledge. Our research has consisted of a critical investigation of Design Rationale and a modification and expansion of existing approaches into a new approach which we call Argumentative Design. Results from the research are new (modified) abstracted design knowledge (concepts, theories, models and methods) which are aimed for the research and practice communities. We would like to emphasize that abstracted design knowledge ultimately is aimed for practical use in design work. This means that practice community is a primary target group for abstracted design knowledge. This follows the pragmatic view on knowledge and research; knowledge is aimed to contribute to the improvement of human life (Dewey, 1938). A design theory can be seen as special kind of a *practical theory* (Cronen, 1995; 2001; Goldkuhl, 2008). Cronen (1995 p 231) describes practical theories in the following way: "They are developed in order to make human life better. They provide ways of joining in social action so as to promote (a) socially useful description, explanation, critique, and change in situated human action; and (b) emergence of new abilities for all parties involved".

Existing design knowledge may also comprise explanatory theories which are relevant knowledge for design; for example systematized knowledge about use of artefacts with certain characteristics. Walls et al (1992) call such knowledge 'kernel theories'.

The different Design Rationale approaches, which form the knowledge basis for this research, are abstracted design knowledge. They involve some basic constructs (e.g questions, options, criteria as in QOC) which should shape the design process. They involve also modelling languages/notations aimed for use in practical design as a methodological support. We cannot claim that the DR approaches have been formulated as design theories according to standards of Walls et al (1992) or Gregor & Jones (2007). However, it is possible to consider them as embryonic design theories. They have dual foci; both on design process and design product. One main purpose is to make the design process more argumentative and transparent. The designed artefact (i.e. design product) should be the result of socially rational judgements. The result should not only be the artefact itself but also a model of the arguments behind it.

The result of our presented research is a modified and expanded Design Rationale approach called Argumentative Design. It is a result of theoretical/conceptual and empirical design oriented process. This means that we present both theoretical and empirical grounding in line with Goldkuhl (2004).

### *2.2 Introduction to the empirical example: e-service for food permit*

The process of using and developing Argumentative Design is part of a larger research project which is a joint project between four municipalities and some researchers. An aim of that project is improving the conditions of commercial and industrial life in municipalities. The study started with a broad process analysis discovering problems and goals concerning the interaction between the companies and the municipalities. Based on this investigation a decision was taken to start developing e-services and redesigning processes. Important issues have for example been: How can companies and municipalities benefit from an e-service? How can companies and municipalities communicate with each other through an e-service?

How can companies interact with an e-service? The work with the future e-service has implied to handle a multitude of design issues at different levels. As indicated above, the research process has been conducted as action research. Two researchers have worked as designers of the e-service. The design has been pursued in a close and continual interaction with some of the case handlers from the municipalities.

One part of the research project was to develop an e-service for food permission[1]. A company may need permissions from the local authority to set up and run a business. Permissions are often necessary e.g. when selling food. To get food permission easily and quickly is important for the company since permission is a prerequisite for running a business in a legal way. An e-service that allows companies to easily apply for a food permit, and quickly get answers from the municipality would help companies to start up businesses. It is pivotal for the municipality that it is easy to set up and start a business. Such an e-service is important for companies as well as the municipality.

When analysing this permission process we found inter alia that it may take time before the company can start the food business because of problems with the business registration certificate. The company may not have a certificate up to date or fail to submit a certificate. Thus problems with the business certificate may have a negative effect on the municipality's goal of simplicity for companies. The aim of developing an e-service was to support both companies and case handlers at the municipality. Besides making it easier for companies the aim was also to ensure that case handlers achieved correct and sufficient information.

We identify six main phases in the current process of food permit application for food business, described in the process diagram below (figure 2.2):

1. The company plans the food business, e.g. a food store or restaurant.
2. The company acquires a business registration certificate from the business registration agency.
3. The company submits the food application (including the business certificate) to the municipality.
4. A case handler at the municipality assesses the application; in this assessment process the case handler also uses an IT system.
5. The municipality decides on the food application and sends the decision to the company.
6. If a permit is issued, the company starts the food business, e.g. selling food or serving meals to guests.

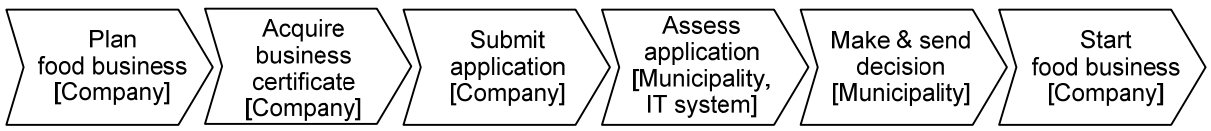


*Figure 2.2 Food permit application for food business (current process)*

The planned future process of food permit application which includes an advanced e-service is described in figure 2.3. The e-service is used by the company for filling in a form and sending the application to the municipality. The company also obtains answers (food permit decisions) from the municipality by the e-service.

[1] This research has been described elsewhere; Röstlinger & Cronholm (2009).

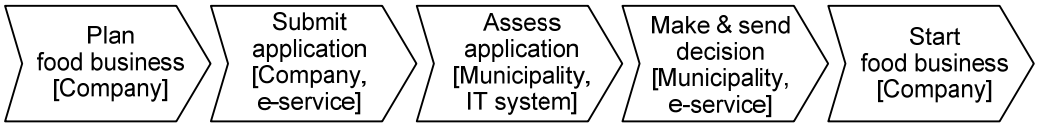


*Figure 2.3 Food permit application for food business (new process with e-service)*

Currently the business registration certificate is a paper-based document which is issued by the business registration agency on demand from the company. How to treat this document together with the e-service? When designing the new process we found that the need for a paper-based document would be negative in order to exploit the potential of the e-service. Because of this, the first question in order to find an appropriate solution to the problem was: Do the case handlers at the municipality need the business registration certificate or is it sufficient to obtain the information on the certificate, i.e. information about the business registration? In this case, it was up to date information obtained in a secure way which was important for the case handlers, not the paper-based document itself. Thus there existed prerequisites for electronic processing of information on business registration.

After investigating the conditions of both the municipality and the business registration agency we created three alternative solutions on handling the business registration information. The design of the three partly different processes is described in the process diagram in figure 2.4. Interaction between the stakeholders in the different alternatives can be seen in figure 2.5.

- Alternative I: The company is responsible to make the business registration information available for the municipality. The company has to obtain a business certificate; by ordering a new one from the Business Registration Agency or pick one that the company has received previously. The company has also to submit the business registration information to the municipality. Either Ia) send the certificate by surface mail (together with the application or separately) or Ib) make a scanned copy and send it electronically (included in the application sent by the e-service or separately by e-mail).
- Alternative II: The case handler at the municipality is responsible to make the business registration information available when handling the application. The case handler has to search for and download business registration information from a data base at the Business Registration Agency.
- Alternative III: No person is responsible for providing the case handler with information about the business registration. This is instead automatically handled by the e-service system. The system searches and downloads business registration information from the data base of the Business Registration Agency.

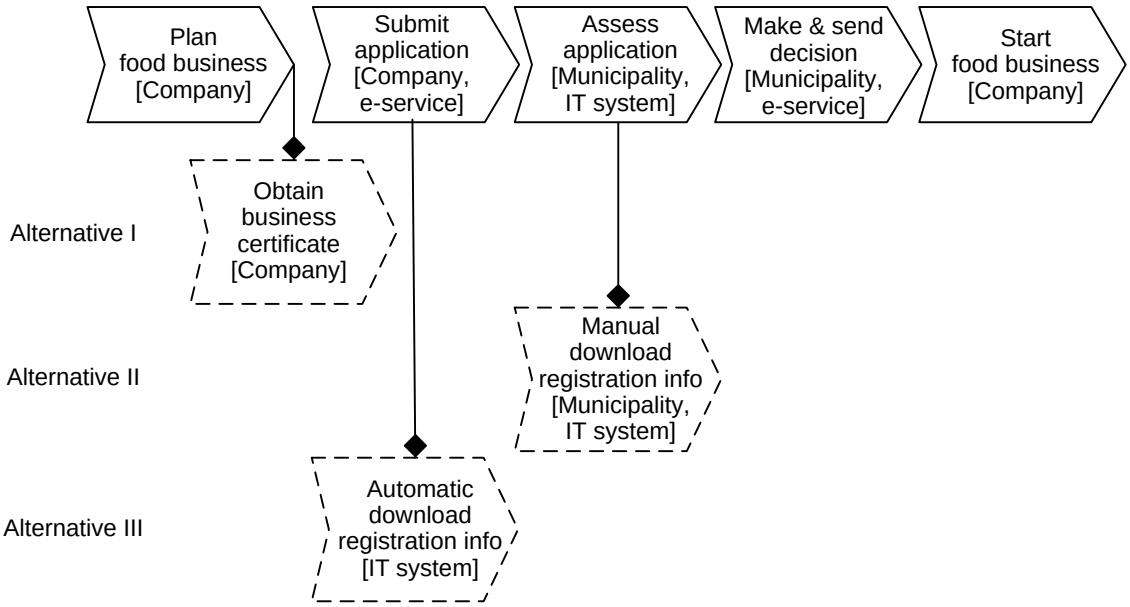


*Figure 2.4 Food permit application for food business*
*(new process with e-service – three design alternatives)*

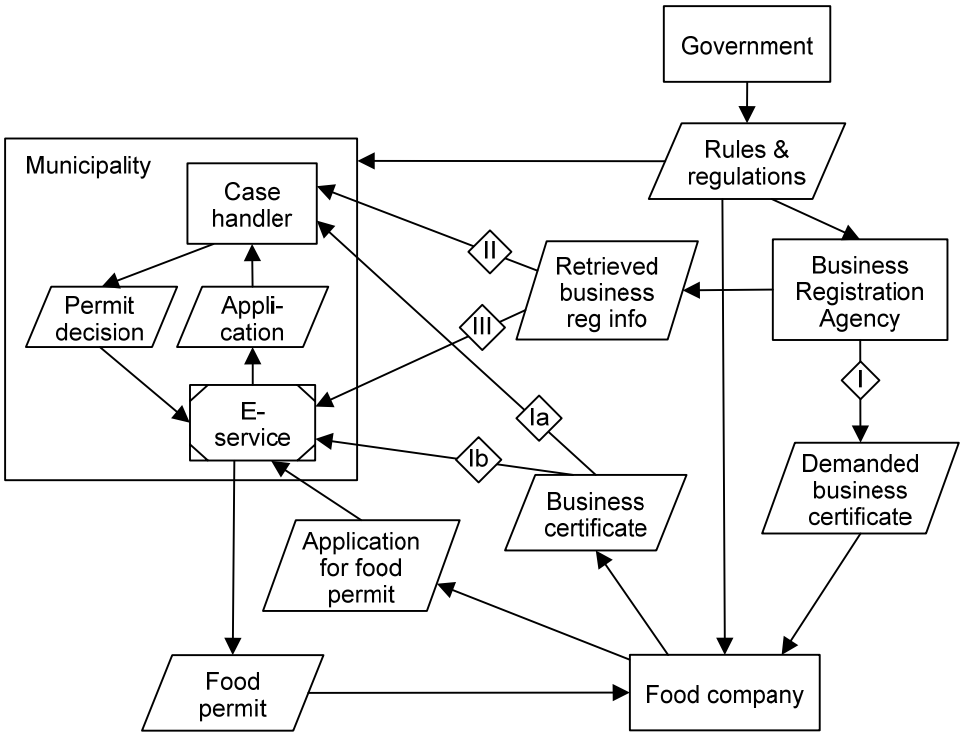


*Figure 2.5 Food permit application for food business: Interaction between actors*

## 3 Design Rationale

### *3.1 Main ideas and concepts*

The main idea of Design Rationale is to have the design process transparent and socially rational through making design alternatives clear together with pro and con arguments. Design Rationale is described to be a documentation of the arguments behind a designed artefact (MacLean et al, 1989). Buckingham Shum & Hammond (1994) summarize several roles that Design Rationale may play in design processes: Structuring design problems, maintaining consistency in decision-making, keeping track of decisions, communicating design reasoning to others, as a chronological record of the design process, assisting the integration of theory into design practice and supporting the building of cumulative design knowledge, through reusing DR.

The main theoretical grounding comes from Rittel's theorizing concerning wicked problems mentioned in section 1 above (Rittel, 1972; Rittel & Webber, 1973). Wicked problems are so complex to resolve that a clear explication of design issues, design alternatives and arguments needs to be done. Design Rationale is built on (usually) three meta-concepts: 1) Issues, 2) positions and 3) arguments (e.g. Conklin & Begeman, 1988); cf figure 3.1. There are several other labels (and partially also re-conceptualisations) of these main concepts. We will return to this below when discussing different DR approaches[1]. One of these approaches is IBIS which has its clear origin in Rittel's work. Kunz & Rittel (1970) formulated the idea of an Issue-Based Information System (IBIS) which should make the argumentation process transparent when encountering wicked problems. It is however interesting to see that the three main meta-concepts mentioned above are not as clear as one could presume in the work of Kunz & Rittel (1970). The concepts they mention include these three concepts, but also other concepts as well: "Elements of the system are topics, issues, question of fact, positions, arguments, and model problems" (ibid p 1). We have reviewed many DR publications but we have not found any arguments why the concentration on these three concepts is made and the others are excluded.

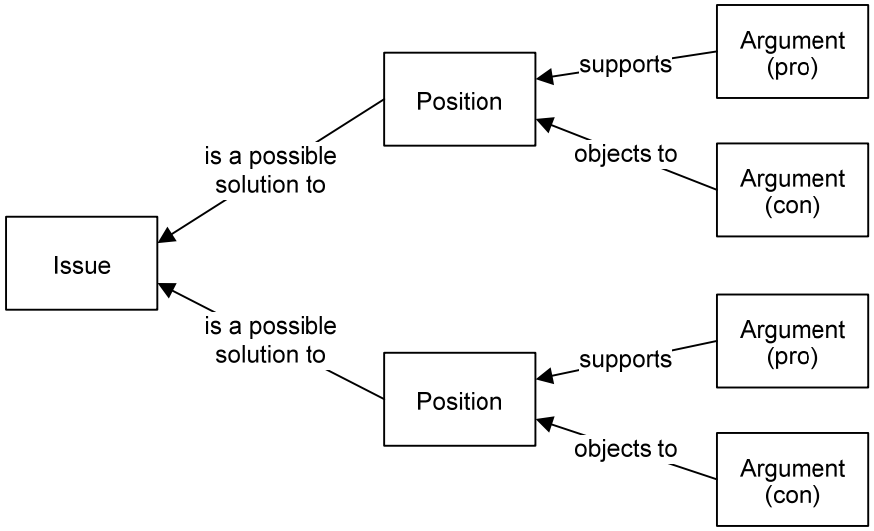


*Figure 3.1 Basic constructs and relations of Design Rationale*

[1] We talk about DR *approaches*. We could use the concept 'method'. We use the concept 'approach' to mean that they possibly but not necessarily cover concepts, procedure and notation.

### *3.2 Design Rationale approaches*

The history of Design Rationale (cf Buckingham Shum & Hammond, 1994; Buckingham Shum et al, 2006) seems to have started with Rittel's work on wicked problems and IBIS in the early 70'ies. In the late 80'ies there emerged some DR approaches based on Rittel's ideas (Conklin & Begeman, 1988; MacLean et al, 1989). An important step in the development of Design Rationale was a 1991 Special Issue in the journal "Human-Computer Interaction" (Carroll & Moran, 1991). Important overviews of Design Rationale research are made by Buckingham Shum & Hammond (1994) and Buckingham Shum (1996).

We will briefly describe three DR approaches[1,2]:

- IBIS (Conklin & Begeman, 1988; Conklin, 2006)
- QOC – Design Space Analysis (MacLean et al, 1989; 1991)
- DRL – Decision Representation Language (Lee & Lai, 1991)

The IBIS approach described here is the "Conklin version" of IBIS starting with Conklin & Begeman (1988) and Conklin & Burgess Yakemovic (1991). Conklin seems to have been actively working with IBIS for many years. In 2006 he presented a book (Conklin, 2006) on this issue containing an integrated description of IBIS (as method and notation), cooperation forms (the dialogue mapper working as a facilitator) and a dialogue environment (including computer software[3] and the use of a shared display). In the 88'version the main concepts used were issue, position and argument (Conklin & Begeman, 1988). In the 06'version the following terminology was used: Question, idea, argument. Argument can be of pro or con character.

It is interesting to see that the original IBIS version of Kunz & Rittel (1970) is described as a general approach to wicked *policy* problems; that it is "meant to support coordination and planning of political decision processes" (ibid p 1). Conklin & Begeman (1989) describes IBIS as a method for resolution of *design* issues, which seems to be a more narrow conception of the approach. In Conklin (2006) the scope has been widened again; IBIS as general tool for structuring of *discussions* and *meetings*.

The QOC approach of MacLean et al (1991) resembles the IBIS to a large degree. There are however some important differences. They use the label 'Design Space Analysis' to describe their approach. They want to emphasize that DR should be used to clarify the design space (possible design alternatives) and the considerations for choosing among them. They say that "a design rationale is a representation for explicitly documenting the reasoning and argumentation that make sense of a specific artefact" (ibid p 203). Their main concepts are question, option, criteria (QOC). Question and option correspond well to issue and position in IBIS of that time (Conklin & Begeman, 1988). There is however a difference between criteria (of QOC) and argument (of IBIS). MacLean et al (1991) criticizes IBIS for not being explicit concerning criteria. IBIS schemes "do not explicitly bring forth criteria. IBIS has Arguments for and against Positions, but IBIS Arguments only implicitly refer to what we would call

[1] We have left out, from this discussion, PHI – Procedural Hierarchy of Issues (Fischer et al, 1991), since this approach seems mainly to be occupied with the structuring of different issues.

[2] A review of different approaches is made by Lee & Lai (1992). Confer also Buckingham Shum & Hammond (1994).

[3] There have been many software tools for support of IBIS and other DR approaches over the years; cf. e.g. Buckingham Shum et al (2006) for a historical overview. Conklin (2006) uses and describes the software tool Compendium (http://compendium.open.ac.uk/).

Criteria. Criteria per se are not proper objects of the IBIS notation" (ibid p 214 f). This discussion concerning arguments vs. criteria is important and we will return to this when elaborating our Argumentative Design approach in section 4 below. We just conclude, for the moment, that there is some controversy concerning the use of these concepts in Design Rationale.

Lee & Lai (1991) present a DR approach with more concepts in their Decision Representation Language (DRL). This is based on a critical review of both IBIS and QOC; confer also Lee & Lai (1992). They found IBIS to be limited in its expressiveness in relation to criteria: "Because criteria are not explicit, we cannot argue about them; we cannot represent the reasons for having these criteria; and we cannot indicate any relationship, such as mutual exclusiveness, among the criteria. Further, when criteria change, there is no easy way to accommodate the changes. It would be more difficult to isolate the real disagreements among people, because the criteria they use in their arguments remain implicit" (Lee & Lai, 1991 p 273f). QOC is also criticized for not having sufficient expressiveness concerning criteria. QOC is criticized for having an unclear vocabulary. In DRL there are several concepts covering a broader conceptual space. DRL comprises the following concepts: Decision problem, alternative, goal, claim, question, procedure. Goals correspond to criteria of QOC. A claim is a kind of qualifier determining if an alternative will reach a goal or not.

Among these three approaches DRL is the one with most concepts and thus expressive capabilities. This is for good and bad. Many meta-concepts let us express design problems in a nuanced way. On the other hand, many concepts (and corresponding symbols in models) may make the notation and models hard to learn and use. In a decision graph all the above mentioned meta-concepts are included having different symbols.

As we can see from this brief review of different DR approaches there are variations in terminology between them concerning the main concepts (figure 3.2). We consider that the first two concepts (issue and position and their respective equivalencies) only are matters terminological differences. Concerning the third group of concepts (argument, criteria etc) there seems to be conceptual differences between the three approaches. This can be seen from the above review. QOC is criticizing IBIS for not being explicit concerning criteria and DRL criticizes IBIS and QOC for similar reasons.

| **IBIS'88** | **IBIS'06** | **QOC** | **DRL** |
|---|---|---|---|
| Issue | Question | Question | Decision problem |
| Position | Idea | Option | Alternative |
| Argument | Argument | Criteria | Goal, claim |

*Figure 3.2 Conceptual comparison between some DR approaches*

## 4 Argumentative Design

In this main section of the paper we present our extended and modified version of Design Rationale. We call this approach Argumentative Design, since we find this label more appropriate for the type of approach: The design process should be conducted in an argumentative way. The term 'argumentative design' is not new at all. It has been used by several authors earlier to characterise this type of approach; e.g. Fischer et al (1989), Holmgren (1992) and Buckingham Shum & Hammond (1994).

The development of this approach has been conducted in close connection with empirical design work (introduced in section 2.2 above). We have also been inspired by teaching DR to master students. We have used DR according IBIS (Conklin, 2006) and added extensions which will be described below. We build on earlier work on DR development presented in Goldkuhl (1991) and Holmgren et al (1992). Our extensions to "narrow" DR are based on our method development of change analysis/SIMM (e.g. Goldkuhl & Röstlinger, 1984; 1988; 1993; 2003; 2005; Röstlinger & Goldkuhl, 2006).

### *4.1 Arguments vs. criteria*

As described above (section 3.2), there is some controversy concerning concepts in Design Rationale. There are disputes concerning the third concept which is concerned with the rationale for the various alternatives. There are different concepts circulating: Argument, criteria, goal, claim. We do not find this conceptual controversy sufficiently explicated which is a necessity for getting it resolved.

We use the e-service case (section 2.2 above) to illustrate problems and our reasoning. There is a design issue in this case which we will use:

*"How will case handlers get information about the company's business registration?"*

Two initial design alternatives were suggested:
I). Companies submitting a business certificate
II). Case handlers download registration information electronically

Different pro and contra arguments were generated and documented in an Alternative diagram (figure 4.1). Alternative diagram is the notation used in Argumentative Design corresponding to DR maps[1]. We have changed the symbols slightly in relation to IBIS maps. In figure 4.2 a principal Alternative diagram is depicted.

In alternative I it takes time for the companies to obtain a business certificate and submit it to the municipality. On the other hand, there will be no effort for the municipality to obtain registration information. In alternative II, companies do not need to handle any registration information and there will be no costs for them. In alternative I there will exist a separate document (a business certificate) which is good. In alternative II, there will be no such document since the case handlers will only get this information electronically.

[1] Conklin (2006) uses the term 'Dialogue map'. In QOC, MacLean et al (1991) uses 'QOC diagram'. In DRL (Lee & Lai, 1991) the corresponding model is called 'Decision graph'.

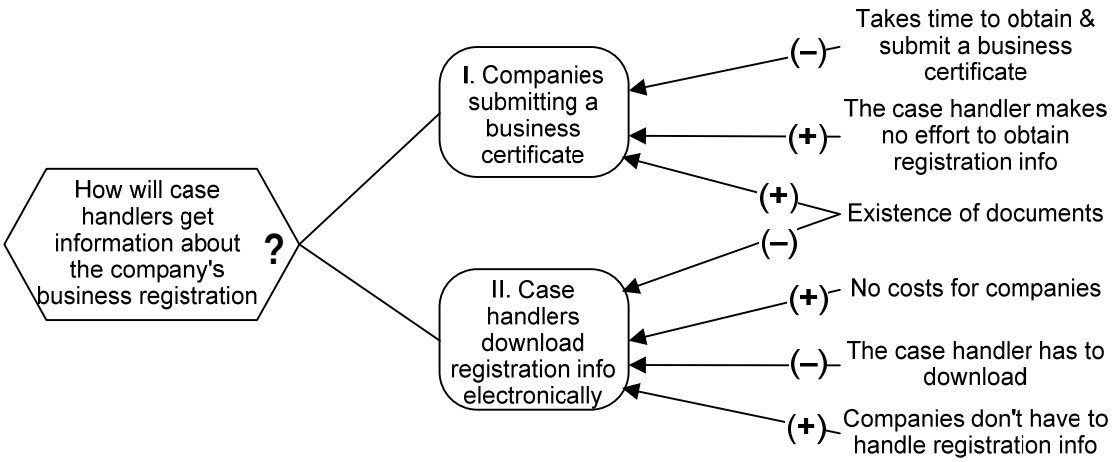


*Figure 4.1 First Alternative diagram*

As seen from the alternative diagram (figure 4.1) both pro and contra arguments for the two alternatives have been identified. These arguments contribute with an initial assessment of these alternatives but do not give any clear indication which alternative to chose. It is necessary to make a more thorough and systematic evaluation and comparison.

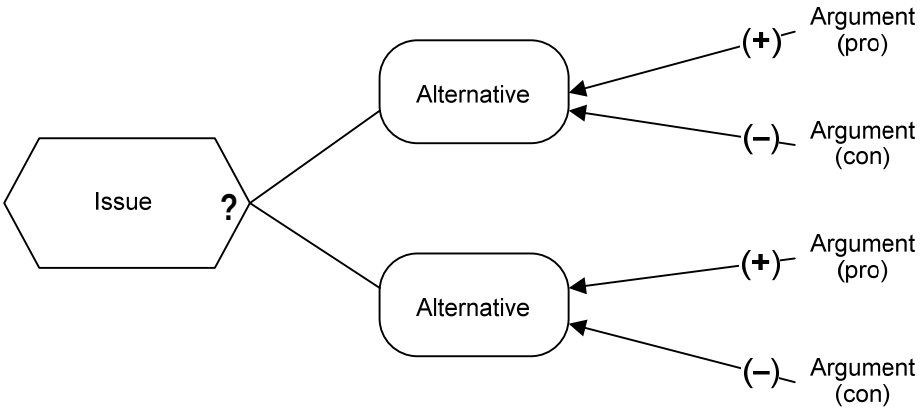


*Figure 4.2 A principal Alternative diagram*

To make a rational comparison between the two alternatives, it is necessary to have a joint basis for comparing the alternatives. For example in alternative I it takes time for the companies, but in alternative II it will not take any time. In the alternative diagram, a pro argument for alternative II was identified: “No costs for the companies”. There was however no corresponding cost argument concerning alternative I. Such an argument could read like “Companies pay for business certificate”.

To make a fair comparison, every argument needs to be related to both alternatives. For example, there might be an argument “costs for companies” which will be a pro argument for alternative II and con argument against alternative I. This means also that the arguments need to be formulated in a neutral way. For example, the argument “Companies don't have to handle registration info” has been reformulated to “Work input for companies” in order to fit as argument in relation to both alternatives. A revised Alternative diagram is found in figure 4.3. In this diagram, all arguments from figure 4.1 have been reformulated to neutral ones,

except for “Existence of documents”[1] which was already given such a neutral formulation and also having two argumental relations to the two alternatives. We have also added one more argument, “Up to date information on companies”, to show that more arguments can be found continually when working with new diagrams.

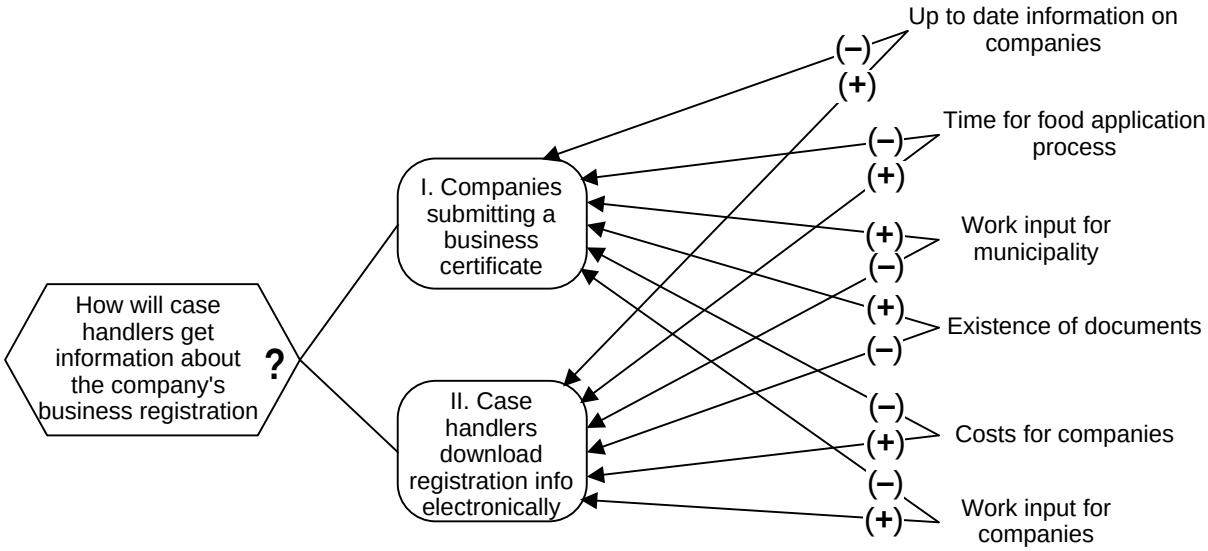


*Figure 4.3 A revised Alternative diagram*

The different formulations of arguments in the two Alternative diagrams (Fig 4.1 vs fig 4.3) are important. What do these variations in formulations imply? It is time to return to the conceptual controversy on arguments vs. criteria (section 3.2 above). One way to characterise the difference between the two diagrams is to say that figure 4.1 is an IBIS-oriented diagram[2] and figure 4.3 is a QOC-oriented diagram. In figure 4.3 the arguments have turned into criteria. “Companies don't have to handle registration info” is an argument in favour of alternative I (figure 4.1). “Work input for companies” is the corresponding criterion used to judge both alternatives I and II (figure 4.3).

A way forward is to make conceptual meta-models for clarifying the conceptual basis for Design Rationale and Argumentative Design. In figure 4.4 a conceptual meta-model of the basic IBIS conception of DR is depicted. We have used the concepts issue, alternative and argument, which are parts of the terminology for our approach Argumentative Design.

[1] Figure 4.1 follows mainly the IBIS approach which will be commented below. In the Compendium software tool (supporting IBIS) there is an option to have arguments of neutral character (+–).
[2] As said above, in figure 4.1 (the ”IBIS-oriented” diagram) there is already one example of a neutral argument or criterion (“existence of documents”).

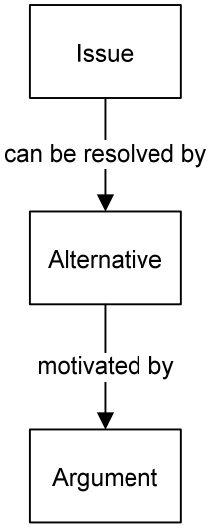


*Figure 4.4 Conceptual meta-model: Basic DR-model*

In IBIS-oriented DR, it is important to differentiate between the pro and con arguments. This is shown in a refined conceptual meta-model (figure 4.5).

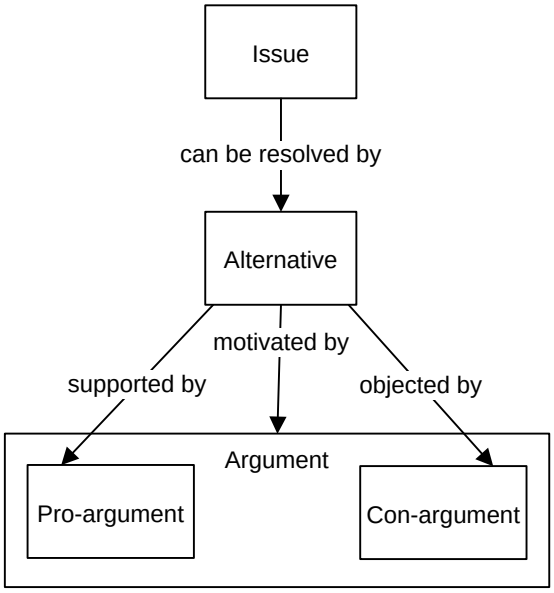


*Figure 4.5 Conceptual meta-model: Basic DR-model (pro/con arguments)*

We have made above, by the aid of our empirical example, an initial illustration of the conceptual controversy concerning arguments vs. criteria. We will continue this below in the next section.

### *4.2 Arguments = criteria + consequences*

We would like to make some comments on the usefulness and communicability of the two Alternative diagrams above. Figure 4.1 with different pro and con arguments is fairly easy to read. What is in the diagram is fairly easy to comprehend. As said above, the diagram is however incomplete for making a fair comparison and evaluation. This diagram is only useful as an initial step in the design and evaluation process. To have a good basis for evaluation

there is a need for a comparative and thus more complete basis. This can be in the form of criteria or at least to have arguments that are comparable. To just have one argument related to one design alternative does not give a comparable basis. It is not enough only to say "no cost for companies" as an argument for alternative II. It is also necessary to say something about costs for companies for alternative I. Otherwise there will be no fair comparison. The criterion (or neutral argument) "cost for companies" is used to assess the two alternatives. This criterion gives (as indicated above) a pro argument for alternative II and a con argument against alternative I. This can be read from the revised Alternative diagram (figure 4.3). This Alternative diagram gives thus a more complete picture of the argumentative basis for the design alternatives. It is more comprehensive, but perhaps not so easy to comprehend. The more criteria that is added, the more difficult will it be to read. The diagram will be cluttered with many lines. The communicability of the Alternative diagrams will continually get lost when becoming more comprehensive.

An alternative way to illustrate this complexity is to use a matrix. A matrix showing alternatives and criteria gives a more condensed description form. In figure 4.6 an Alternative-matrix is shown.

| **Issue**: How will case handlers get information about the company's business registration? | | | | |
|---|---|---|---|---|
| **Alternatives** / **Criteria** | **I. Companies submitting a business certificate** | | **II. Case handlers download registration info electronically** | |
| **Time for food application process** | Takes time for companies to obtain & submit a business certificate | - | The case handler can quickly (when necessary) retrieve registration info electronically | + |
| **Work input for companies** | Companies must order the business certificate & submit it | - | Companies don't have to handle registration info | + |
| **Work input for municipality** | The case handler makes no effort to obtain registration info | + | The case handler has to download | - |
| **Costs for companies** | Company pays for the business certificate | - | No costs | + |
| **Costs for municipality** | No costs | + | Low transaction cost | - |
| **Existence of documents** | There is a physical document | + | There is no physical document | - |
| **Up to date information on companies** | A physical business certificate may contain outdated info | - | Electronic registration info is up to date | + |

*Figure 4.6 Alternative-matrix*

In this matrix there are two columns with the alternatives and several rows with criteria. A matrix of this kind is used in QOC (MacLean et al, 1989) building on proposal in Marshal (1987) of an "option/goal matrix".

In our Alternative-matrix[1], we do not have only + and – in the cells as MacLean et al (1989) and Marshal (1987). We describe the contents in textual form. What is this textual content that

[1] Our Alternative-matrix is switched in relation to the option/goal matrix of Marshal (1987). We have criteria (goals) in the rows and alternatives (options) in the columns. The reason for this is that we expect that there usually will be more criteria than alternatives in such a matrix. It is easier to expand with more rows than columns in ordinary texts.

is in the cells? There is one criterion “Work input for municipality” in the matrix. This criterion has the following texts in the cells “The municipality makes no effort to obtain registration info” (alternative I) and “The municipality has to download” (alternative II). This means that each alternative is characterized according to the criterion. The criterion specifies (through its textual formulation) some relevant feature of designed alternatives. This is a *type of property*. Each alternative will have some “value” for this type of property. We can say that there are different *design consequences* (particular property values) of the proposed design alternatives. There is e.g. a criterion/property type “Work input for municipality” that is used for evaluation and comparison of the two design alternatives. In alternative I, the consequence following this criterion is that “The municipality makes no effort to obtain registration info”. In alternative II, the consequence is that “The municipality has to download”. We describe thus consequences of each alternative in the cells. A consequence is determined by a criterion and an alternative together. This kind of explicit consequence formulation makes it easier to understand and asses the alternatives related to criteria. This is also a way to further clarify the alternatives through their properties and effects.

The consequence “The municipality makes no effort to obtain registration info” can be found in the earlier documentation. Figure 4.1 (the first Alternative diagram) comprises this text as an argument. This means that what is here defined as a consequence corresponds to what is called argument in the IBIS approach (e.g. Conklin, 2006). We will elaborate this further below.

We add also the positive (+) and negative (–) assessment of each consequence in the cells. This is made in order to have a clear statement of what kind of evaluation is made; if it is a pro argument or con argument. This assessment is made according to some comprehension of what is good and what is bad in relation to a particular criterion. Criteria are formulated in a rather neutral manner, which can be seen from e.g. figure 4.6. To make a judgement of alternatives’ consequences, there must be some clarification of what is desirable and valuable concerning the criteria. For example low costs are better than higher costs.

In figure 4.5 above a conceptual meta-model was depicted. This follows mainly the IBIS approach to Design Rationale with issues, alternatives and pro/con arguments. Following QOC, we have added criteria to the DR documents; both in Alternative diagram (figure 4.3) and Alternative-matrix (figure 4.6). We have also added consequence as an important concept. Alternatives imply always consequences. Criteria are used to evaluate alternatives. A consequence (as property of an alternative) belongs to a criterion (as a property type). As said above, a consequence is determined by the alternative and criterion together. This means that consequence is a conclusion of the evaluation of an alternative through a criterion. These new concepts have been included in a new conceptual meta-model (figure 4.7).

But, what has happened with the concept of argument? Has it disappeared in this conceptual development? What is used in IBIS-oriented DR models as arguments have obviously been changed to consequences in Argumentative Design. Are there not any arguments in models based on Argumentative Design? There sure is! However, argument is not considered to be one “variable” as in IBIS. Argument (in Argumentative Design) is the composite of criterion and consequence. An argument concerning an alternative is what is stated in (parts of) a row in an Alternative-matrix: A criterion and its corresponding consequence. And this includes also the positive or negative assessment of the consequence in terms of + or –. We claim that this inclusive view on arguments is congruent with the analysis in section 4.1 above where we talked about arguments as both valued consequences (figure 4.1) and criteria (figure 4.3).

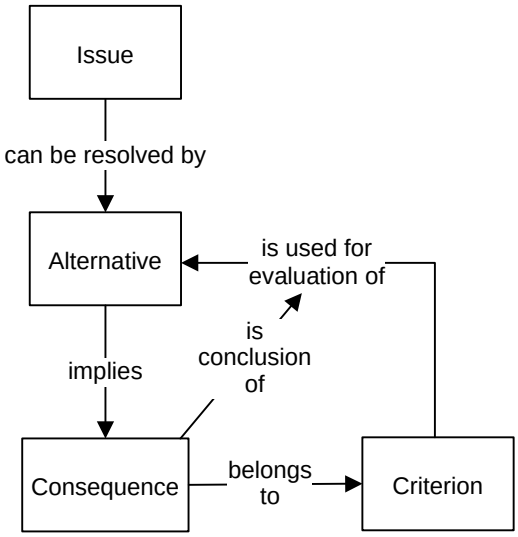


*Figure 4.7 Conceptual meta-model: Basic DR-model (consequence and criterion)*

If we make a sharp comparison concerning 'argument' with IBIS and QOC, there are of course differences between the meanings of the word. Argument of IBIS corresponds to our notions of consequence and assessment. Argument of QOC corresponds to our notion assessment. A conceptual meta-model that describes argument consisting of criterion and consequence is depicted in figure 4.8.

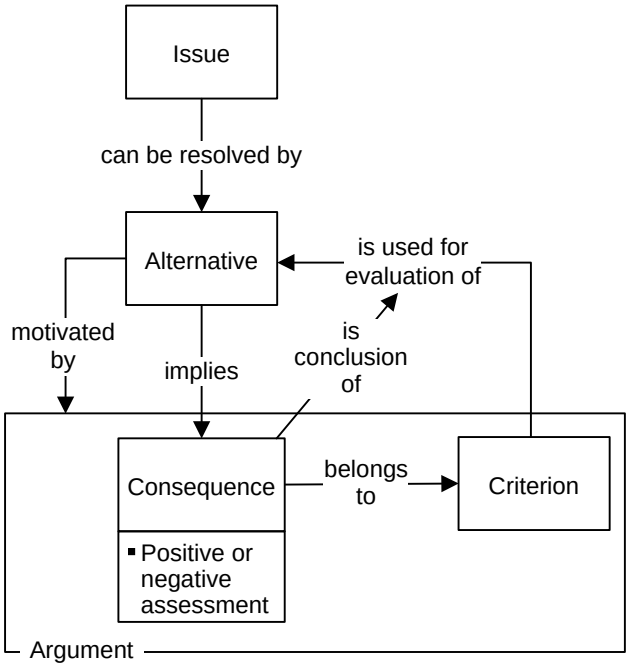


*Figure 4.8 Conceptual meta-model: Basic DR-model (consequence and criterion as argument)*

### *4.3 Strategies in design evaluation*

We have identified two principal ways when working with Argumentative Design. The design conversation can proceed through different kinds of moves. Argumentation is made through stating and applying criteria and through stating and assessing consequences. Which one

comes first? Criteria or consequence? As we have seen in our work with Argumentative Design and this design example, there can be two different ways of analysing alternatives and bringing forth arguments. We call these two ways:

- Abductive strategy in design evaluation (figure 4.9)
- Deductive strategy in design evaluation (figure 4.10)

In the abductive strategy (figure 4.9), there is first an identification of a consequence. Actually there can be just an argument put forth in an Alternative diagram, like "The municipality makes no effort to obtain registration info" (cf figure 4.1). The inquirers must judge and characterize this argument. Is it a consequence of an alternative or is it a general criterion? In this case it is seen as specific consequence associated with an alternative (I). This is step 1 in figure 4.9; the *identification of a consequence*. The next step (2) is to *abstract this consequence into a criterion* that can be applied to other alternatives[1]. The criterion "Work input for municipality" is formulated (cf figure 4.3 and 4.6). This criterion is then applied for assessing other alternatives. A consequence for the other alternative (II) is identified and formulated; "The municipality has to download" (cf figure 4.6). Evaluating other alternatives with the criterion leading to the *identification of other consequences* is step 3 in the abductive strategy. It is called abductive since it comprises an inductive approach (from consequence to criterion) and a deductive approach (from criterion to consequence).

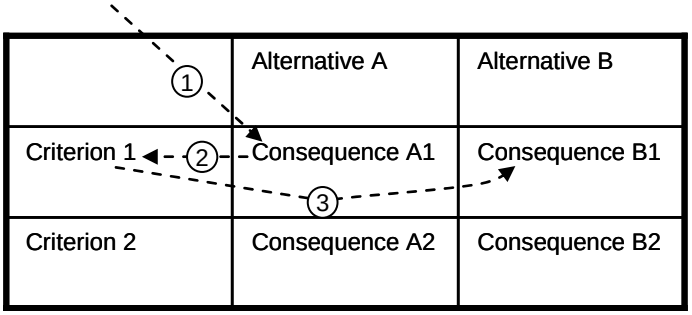


*Figure 4.9 Abductive strategy in design evaluation (from consequence to criteria to consequence)*

The abductive approach is thus not the only possible one. It is possible to follow a deductive approach (figure 4.10) also. This starts (step 1) with an *identification of a criterion*. Actually this can also be just some argument put forth in an Alternative diagram; e.g. "Existence of documents" (cf figure 4.1). This is not considered to be a specific consequence associated with just one alternative. This argument can be related to several alternatives which can be seen from figure 4.1 and is thus considered a criterion. In the alternative diagram (both figure 4.1 and 4.3) there is just an assessment (+ or –) made of the outcome of this criterion-based evaluation of alternatives. The consequences are clearly identified when formulating them in the Alternative-matrix (figure 4.6): "There is a physical document" (I) and "There is no physical document" (II). *Identification of consequences* based on the application of a criterion is step 2 in this deductive strategy. We call it deductive strategy since it goes "top-down" from criteria to consequences.

[1] The transfer of the first Alternative diagram (figure 4.1) to the revised Alternative diagram (figure 4.3) described in section 4.1 above involved just such a reformulation of consequences (initial arguments) to criteria.

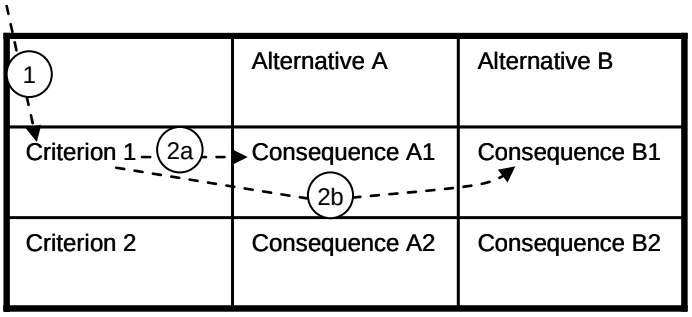


*Figure 4.10 Deductive strategy in design evaluation (from criteria to consequences)*

These two strategies can be applied interchangeably in the design and evaluation process. This is according to our experiences and it can be seen from the description above (sections 4.1-4.2).

### *4.4 Issues and alternatives as parts of the problem solving process*

The discussion so far has been concerned with arguments around the two design alternatives. Not much has been said about the design issue. Once formulated, will the design issue be taken for granted in the following design and evaluation process? Our view is that having a good background understanding of the design issue is pivotal for the design and evaluation. Why is this design issue formulated? It is formulated as one of several design issues in the design of a new e-service for food permit applications. It is formulated as a design issue since today it is problems with business certificates when applying for food permits as indicated in section 2.2 above. It is important that the case handler has correct information about the company including who is the one responsible (the signatory). In the current situation, sometimes there is no business certificate attached to the application. If the company does not have a valid business certificate, they have to order a new one from the Business Registration Agency and this will take some time. These and other problems are described in a Problem diagram (figure 4.11). A problem diagram describes problems and cause- and effect-relations between the problems (Goldkuhl & Röstlinger, 1988; 1993; Röstlinger & Goldkuhl, 2006).

The design issue is concerned with the question of how business registration information is acquired when a food application is submitted through the e-service. It is important that this acquisition of business registration information is smooth and not time-consuming.

So far two design alternatives have been investigated (I and II). Problem solving is often concerned with trying to avoid current problems. Two problems in the current situation are:

- It may take time before the company gets an up to date business certificate to submit
- A business certificate may be missing in the application

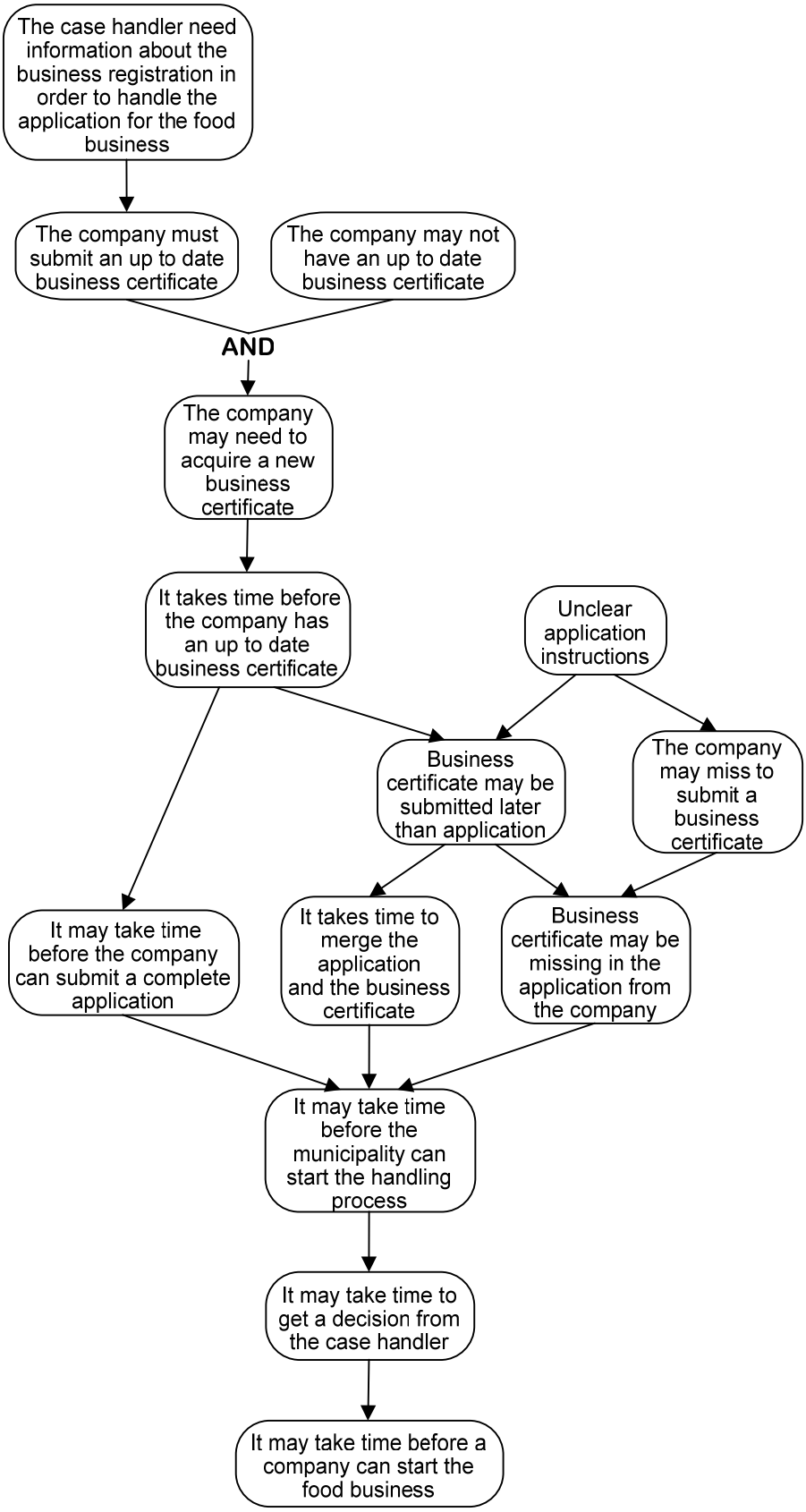


*Figure 4.11 Problem diagram*

One design option is that case handler should download such information from the Business Registration Agency. This is design alternative II described above. There were case handlers participating in the design process that questioned this design alternative since it would take time for them to conduct this download. Such objection was documented in the DR models (e.g. figure 4.6). Objections of this kind and knowledge about the problems driving the design (figure 4.11) led to formulation of a new design alternative: III. Registration information is automatically downloaded via the e-service. This design option was also generated through knowledge about technical capabilities at the Business Registration Agency; that it was possible to conduct such an automatic download. Confer figure 2.5 and also description in section 2.2 where this design alternative was introduced.

A third design alternative needs to be described and evaluated. A new Alternative diagram is produced where this design option is described (figure 4.12). This new Alternative diagram is an expansion of the first Alternative diagram (figure 4.1). This means that important arguments (consequences) are related to the different alternatives. Criteria are not described here as in figure 4.3. Instead we make a comprehensive and more complete account of criteria and consequences in a new Alternative-matrix (figure 4.13).

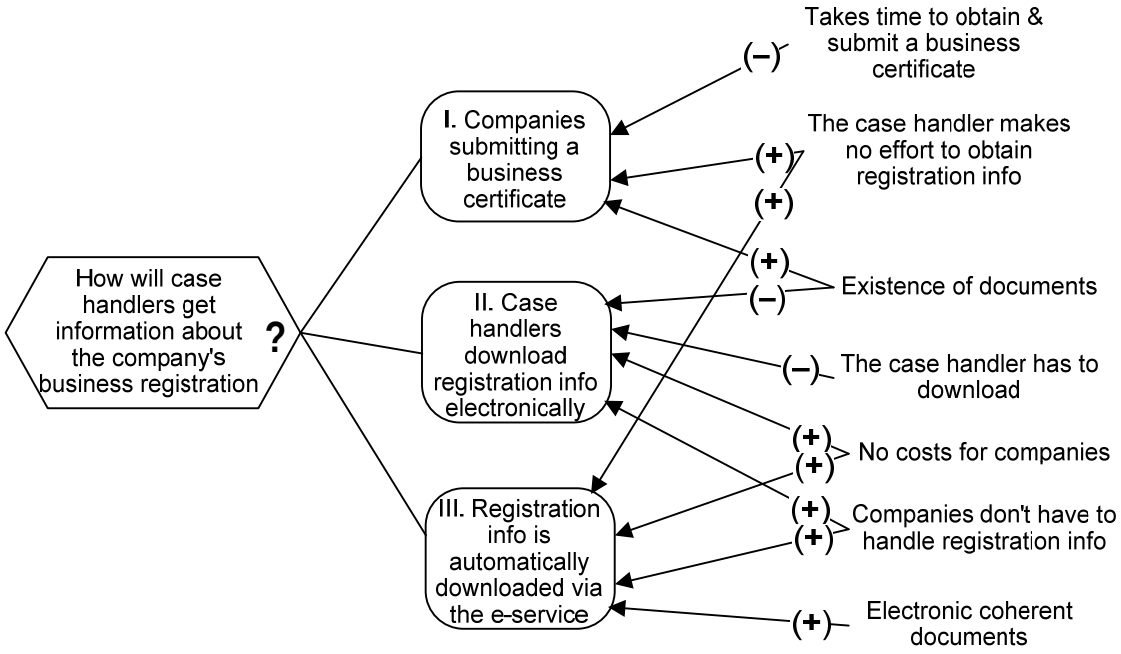


*Figure 4.12 A revised Alternative diagram including design alternative III*

The inspection of the problem analysis (the Problem diagram in figure 4.11) gave also rise to more criteria. One more criterion was added to the list in figure 4.13: “Joined up information”. When handling the application it is necessary for the case handler to have access to business registration information. If the business certificate is sent in later than the application, then the application and the certificate (when arrived) need to be merged. There exists this need for joined up information.

In the first matrix (with two alternatives) we made an assessment of each consequence (+–). This kind of assessment functioned also as an implicit ranking of alternatives with respect to criteria. When having three alternatives, there is a need for explicit ranking besides of the assessment. If two alternatives get a positive assessment, then there is a need to make a

relative ranking between them. In the matrix there are numbers 1, 2 and 3, where 1 is the best ranking. For example, the criterion "Time for food application process" has positive consequences for alternative II and III. The consequence of alternative III ("No delay, the download takes place immediately at login") is considered better - thus ranked 1 - than the consequence for alternative II ("The case handler can quickly when necessary retrieve registration information electronically") which is then ranked 2.

| **Issue**: How will case handlers get information about the company's business registration? | | | | | | |
|---|---|---|---|---|---|---|
| **Alternatives** / **Criteria** | **I. Companies submitting a business certificate** | | **II. Case handlers download registration info electronically** | | **III. Registration info is automatically downloaded via the e-service** | |
| **Time for food application process** | Takes time for companies to obtain & submit a business certificate | - / 3 | The case handler can quickly (when necessary) retrieve registration info electronically | + / 2 | No delay, the download takes place immediately at login | + / 1 |
| **Work input for companies** | Companies must acquire the business certificate & submit it | - / 3 | Companies don't have to handle registration info | + / 1 | Companies don't have to handle registration info | + / 1 |
| **Work input for municipality** | The case handler makes no effort to obtain registration info | + / 1 | The case handler has to download | - / 3 | The case handler makes no effort to get registration info | + / 1 |
| **Costs for companies** | Company pays for the business certificate | - / 3 | No costs | + / 1 | No costs | + / 1 |
| **Costs for municipality** | No costs | + / 1 | Low transaction cost | - / 3 | Low transaction cost | - / 2 |
| **Existence of documents** | There is a physical document | + / 1 | There is no physical document | - / 3 | Registration info is in the application | + / 1 |
| **Up to date information on companies** | A physical business certificate may contain outdated info | - / 3 | Electronic registration info is up to date | + / 1 | Electronic registration info is up to date | + / 1 |
| **Joined up information** | If a business certificate is sub-mitted separately the documents are not coherent, merging required | - / 3 | Separate search is done by the case handler, not coherent documents | - / 3 | Electronic coherent documents | + / 1 |

*Figure 4.13 Alternative-matrix expanded with alternative III*

The design issue should be well reflected in the background problems. As Design Rationale stands in existing DR approaches (section 3.2), there is a focus on grounding of alternatives through arguments (possibly including criteria). There is however no grounding of the design

issue itself. Problem analysis (in Argumentative Design) contributes with a grounding of design issues; confer the conceptual meta-model in figure 4.14. The lack of problem analysis in DR is criticized by Buckingham Shum & Hammond (1994): “it is not being used to explore the problem space, but simply to documents incidents or decisions arising from construction” (ibid p 628). Confer also Lewis et al (1991) for arguments for a problem-centred approach in DR.

In the meta-model we have also added two more important aspects. Consequences have not only assessments (+ or –) as properties. Consequences have also a ranking value; confer figure 4.13 and discussion above. We have added a new relation between issue and alternative. It is self-evident that issue can be resolved by alternatives. This means first issue the alternative. But the other way around may also function as a move in a design conversation. Alternatives may give rise two formulation of new issues. If we chose one alternative then we need to solve new design issues. This is described in the DR literature, e.g. MacLean et al (1991) and Conklin (2006).

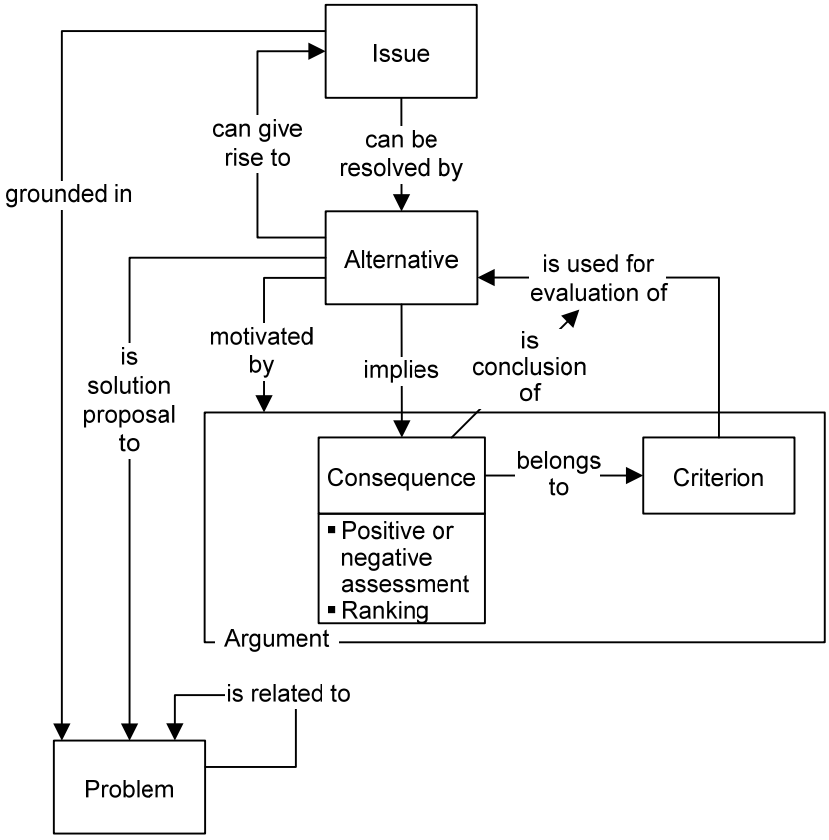


*Figure 4.14 Conceptual meta-model: DR-model (relations to problems)*

### *4.5 Prioritizing criteria through goal analysis*

It is rather obvious from reading the matrix (figure 4.13) that alternative III should be seen as the best one. It gets many number 1 rankings. But can we be really sure when inspecting the matrix that this is really the best alternative. During the design process there were objections from municipal representatives against alternative II and III due to costs and work input. Each consequence is ranked in relation to each other but the criteria are not ranked in any way. The list of criteria in the alternative-matrix (figure 4.13) just follows an arbitrary sorting. There is need for making a prioritizing of different criteria and also to judge if these criteria are

important in the workpractice and for this kind of design decision. The DRL approach (Lee & Lai, 1991), described briefly above, includes hierarchization of goals.

The strive for a transparent and socio-rational decision-making through DR should comprise an explicit focus on goals and that these goals are organisationally relevant. Otherwise, the DR process may just result in decisions based on situational fancies. There is a need for grounding of criteria and decisions in goals.

A Goal diagram (following Goldkuhl & Röstlinger, 1988; Röstlinger & Goldkuhl, 2006) is found in figure 4.15. This Goal diagram contains over-all important goals for the municipality and goals relevant for food businesses and handling of food permit applications. The goals are hierarchized; expressing means-ends relationships. Main goals are in the top of the diagram and sub-goals below. The main goal is “A good municipality for citizens and companies”. In relation the delineated scope, this means that citizens should expect safe food handling in companies and that the municipality offers a good environment for companies to establish and run business. The goal diagram expresses also one goal conflict. “Safe handling of food in companies” requires a thorough investigation by municipal case handlers which can be in conflict with “It should be easy to start a food business in the municipality”.

This Goal diagram is used for assessing the different criteria from the alternative-matrix (figure 4.13). Criteria should be seen as goals in themselves or at least as means supporting goals. The criterion “Work input for municipality” is justified since it contributes to “Low handling costs for the municipality”. The criterion “Work input for companies” may contribute to the goals “It should be easy for the company to make an application” and “Low cost for companies when applying for food business”. This criterion is important since it can be seen as one aspect of the over-all goal to have a business-friendly environment in the municipality.

All criteria need to be checked against the described goals. We do not present all these justifications here. Some examples were given above. It is not sufficient to only make these justifications. Different criteria need to be prioritized. What criteria are most important? Such prioritization gave rise to three priority groups. In the top priority group (A) we find the criteria “Time for food application process” and “Work input for companies” since they are directly related to the over-all goal to have business-friendly environment. A third criterion, which also belongs to this top priority group, is “Up to date information on companies”. This is important since it is necessary pre-condition in order to make a correct case handling and permit decision. Accurate information is a basis for effective handling of food applications. These were the three most important criteria (group A). The rest of the criteria were prioritized in a middle group (B) and a bottom group (C). In this case these three priority groups were chosen. In other cases there might be other kinds of prioritizations.

These priorities are included in the Alternative-matrix. The criteria are sorted given these priority groups. A new Alternative-matrix is shown in figure 4.16. When conducting this analysis a new criterion was introduced; “The company is aware of the information treated by the municipality”. This was important as one aspect of the business-friendly environment and placed in priority group B.

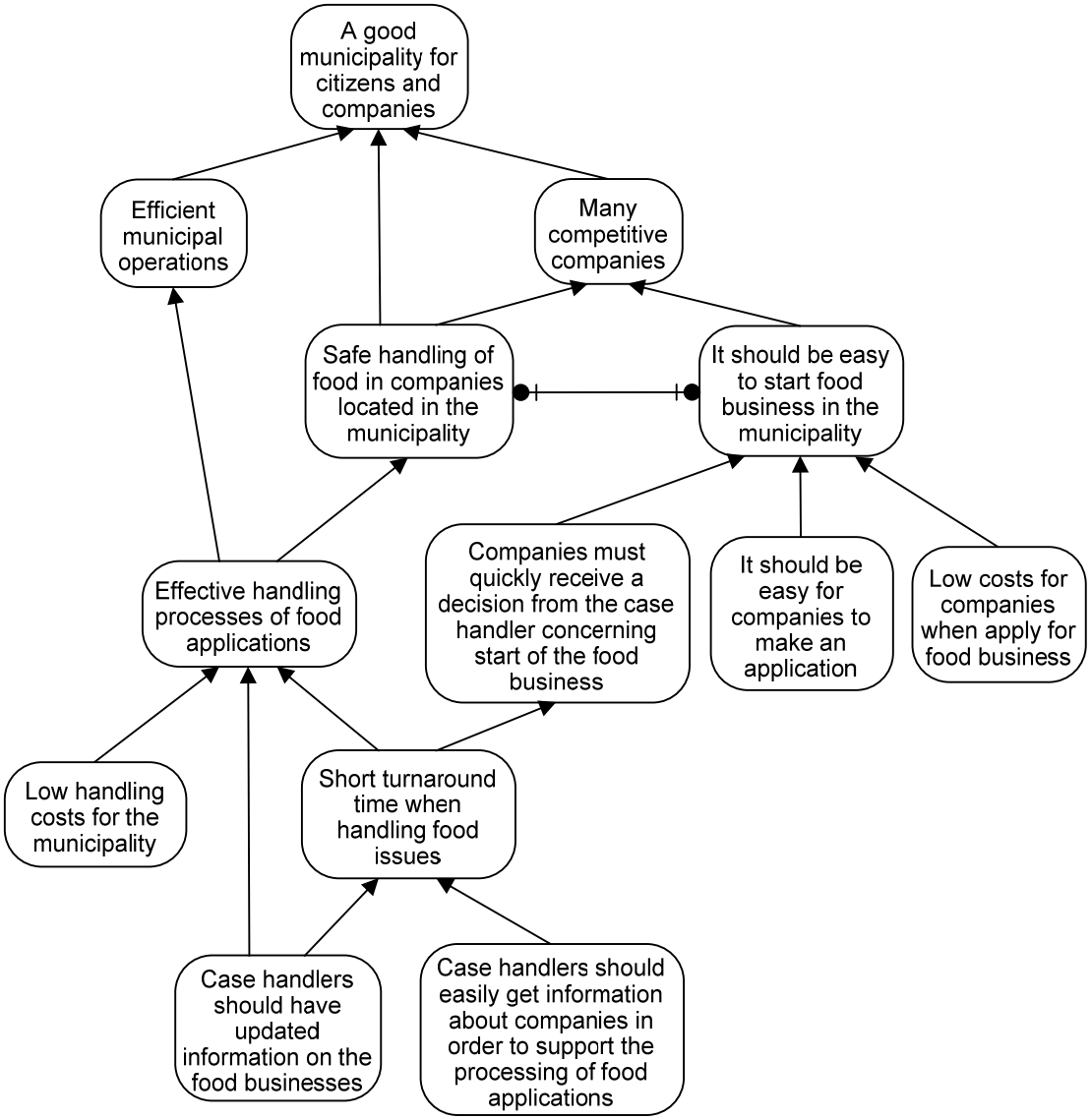


*Figure 4.15 Goal diagram*

When looking at this Alternative-matrix it is actually very easy to come to a rational conclusion and decision. While inspecting the matrix it is obvious that alternative III is the best option. Alternative II is the second best option and the least suitable design option is alternative I. Alternative III is ranked as #1 for all criteria in groups A and B. Alternative B has also some good rankings; two #1 in group A. However, alternative II is never placed before alternative III when ranking consequences.

Arguments (criteria and consequences) need to be justified. They are made so by relating them to goals that are important for the workpractice. A new conceptual meta-model is presented in figure 4.17. In this meta-model, earlier DR concepts have been related to goal and decision. We have also added a property of criterion: Ranking. This was included in the alternative-matrix (4.16), i.e. the priority groups A, B and C.

| **Issue**: How will case handlers get information about the company's business registration? | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Alternatives** / **Criteria** | | **I. Companies submitting a business certificate** | | **II. Case handlers download registration info electronically** | | **III. Registration info is automatically downloaded via the e-service** | |
| **Time for food application process** | A | Takes time for companies to obtain & submit a business certificate | -<br>3 | The case handler can quickly (when necessary) retrieve registration info electronically | +<br>2 | No delay, the download takes place immediately at login | +<br>1 |
| **Work input for companies** | A | Companies must acquire the business certificate & submit it | -<br>3 | Companies don't have to handle registration info | +<br>1 | Companies don't have to handle registration info | +<br>1 |
| **Up to date information on companies** | A | A physical business certificate may contain outdated info | -<br>3 | Electronic registration info is up to date | +<br>1 | Electronic registration info is up to date | +<br>1 |
| **The company is aware of the information treated by the municipality** | B | The company has control over the business certificate | +<br>1 | The company does not see the information downloaded by the case handler | -<br>3 | The company sees the information submitted electronically | +<br>1 |
| **Joined up information** | B | If a business certificate is sub-mitted separately the documents are not coherent, merging required | -<br>3 | Separate search is done by the case handler, not coherent documents | -<br>3 | Electronic coherent documents | +<br>1 |
| **Work input for municipality** | C | The municipality makes no effort to obtain registration info | +<br>1 | The case handler has to download | -<br>3 | The municipality makes no effort to get registration info | +<br>1 |
| **Costs for companies** | C | Company pays for the business certificate | -<br>3 | No costs | +<br>1 | No costs | +<br>1 |
| **Costs for municipality** | C | No costs | +<br>1 | Low transaction cost | -<br>3 | Low transaction cost | -<br>2 |
| **Existence of documents** | C | There is a physical document | +<br>1 | There is no physical document | -<br>3 | Registration info is in the application | +<br>1 |

*Figure 4.16 Alternative-matrix with prioritized criteria*

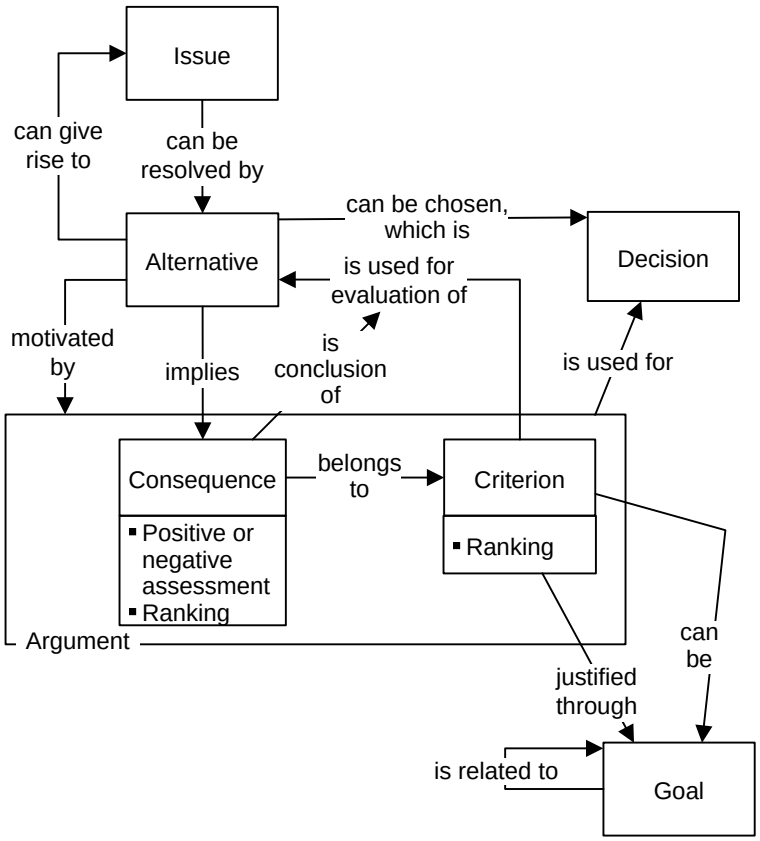


*Figure 4.17 Conceptual meta-model: DR-model (relations to goals and decision)*

### *4.6 Needs for further grounding of design decisions*

This paper took existing Design Rationale approaches as its staring point. The core message of those approaches is to make explicit the arguments for different design alternatives. This is a way to make more proper evaluation of alternatives. The rationale of design decisions should be clear to involved stakeholders.

We do not, however, find existing DR approaches sufficiently explicit in their proposed notations to enable the idea of socio-rational and transparent design and decision process. The justification of design alternatives stops too early. This paper should be interpreted as an argumentation for further grounding in DR. Our proposed approach, Argumentative Design, comprises the following features for further grounding of the design and decision process:

- Every argument concerning a design alternative (being a consequence of that alternative) should be abstracted to criteria which should be applied to all other alternatives
- Consequences of design alternatives need to be identified through application by the same set of criteria
- Consequences (of alternatives) should be assessed in a comparable way
- Consequences for different alternatives (belonging to the same criterion) should be ranked
- Alternately working with consequences and criteria in order to get a rich basis for comparative evaluation
- Design issues grounded in background problems
- Justification of used criteria in goals which are organisationally relevant
- Prioritization of criteria grounded in goals (i.e. ranking of criteria)

- Comprehensive and condensed form of documentation of arguments for different alternatives (the Alternative-matrix)
- Active use of developed knowledge and documentation for decision-making

We have presented our argumentation through the use of an empirical example and conceptual reasoning. This reasoning has been enhanced through the use of several conceptual meta-models. This step-wise argumentation can be seen through the use of the different meta-models. We put here together these models to a final and comprehensive meta-model (figure 4.18) that covers all our categories.

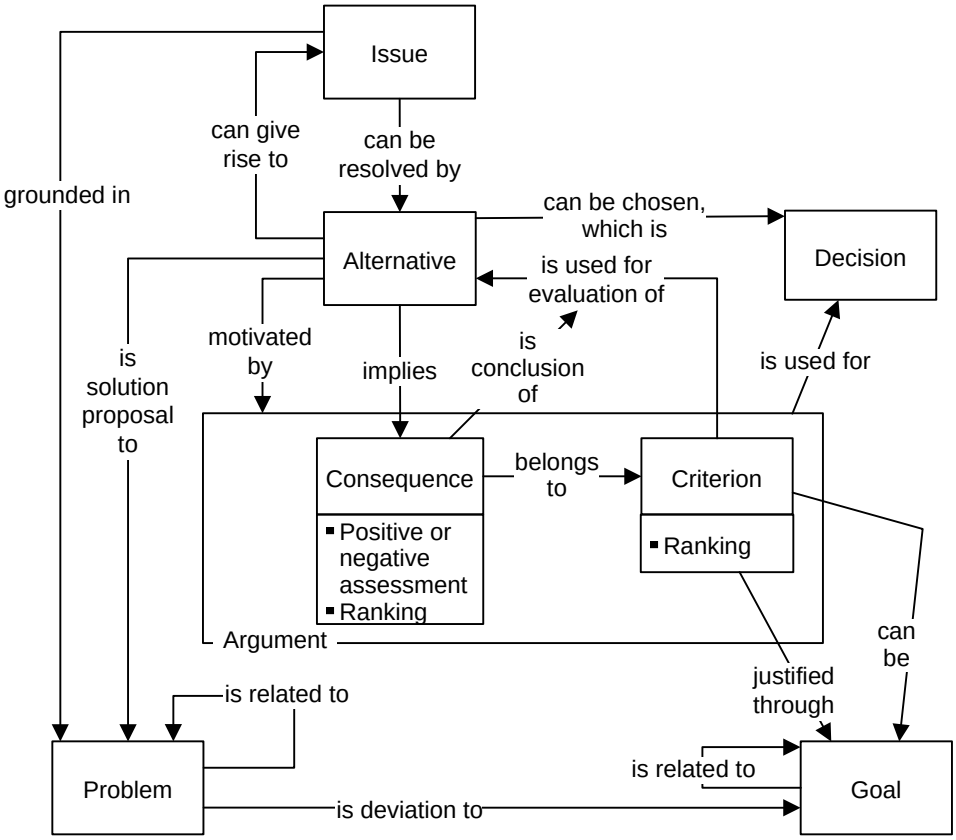


*Figure 4.18 Conceptual meta-model: DR-model (relations to problems, goals and decision)*

In section 3.2 above, we made a conceptual comparison between the three DR approaches IBIS, QOC and DRL (figure 3.2). We extend (in figure 4.19) this comparison through adding our approach Argumentative Design (AD).

| **IBIS'88** | **IBIS'06** | **QOC** | **DRL** | **AD** |
|---|---|---|---|---|
| Issue | Question | Question | Decision problem | Issue |
| Position | Idea | Option | Alternative | Alternative |
| Argument | Argument | Criteria | Goal, claim | Consequence, criteria (goal, problem) |

*Figure 4.19 Conceptual comparison between some DR approaches (extended with Argumentative Design)*

## 5 Conclusions

Argumentative Design, as it is described here, consists of the following notations:

- Alternative diagram
- Alternative-matrix
- Problem diagram
- Goal diagram

We have added several methodological parts as extensions to “traditional” Design Rationale (e.g. IBIS). We have elaborated the evaluation of design alternatives. This is done through a conceptual extension (consequences, criteria, assessments, rankings) and the notation of Alternative-matrix. We have also added analysis of and justification in problems and goals. The methodological structure of Argumentative Design is depicted in figure 5.1.

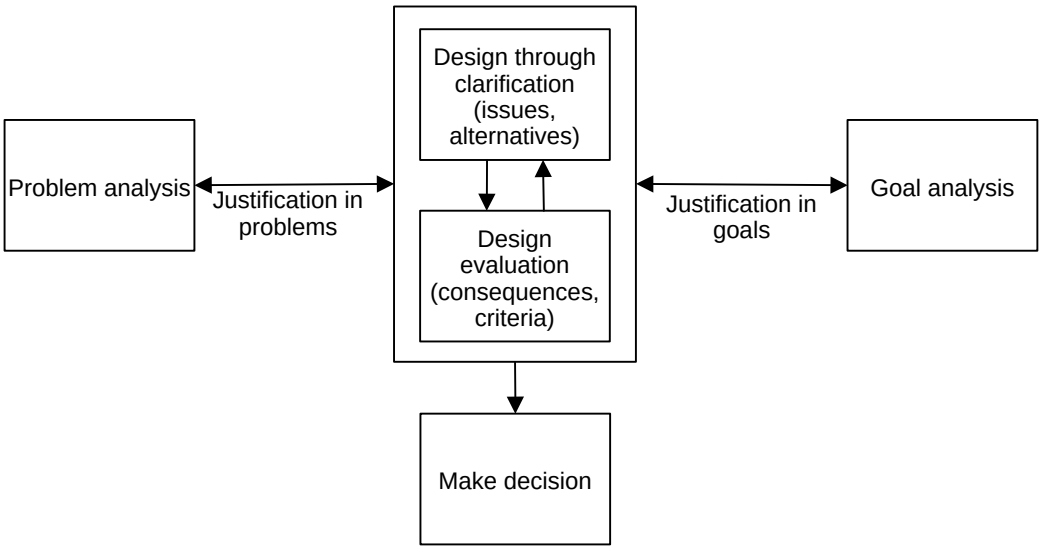


*Figure 5.1 Argumentative Design: Methodological structure*

Argumentative Design takes grounding (as elaborating of reasons) several steps further than earlier Design Rationale. There are several important features of Argumentative Design which were described above in section 4.6. We summarize these features here giving them more condensed conceptual labels in the sake of taking further steps towards a design theory:

- Abstraction of consequences to criteria
- Comprehensive and criteria-based identification of consequences
- Comparable assessment of consequences
- Consequence ranking
- Alternate focus on consequences and criteria
- Issue grounding in problems
- Goal justification of criteria
- Criteria ranking
- Comprehensive and condensed documentation
- Follow documentation in decision-making

Argumentative Design and Design Rationale are important contributions to the design of complex artefacts and practices:

- Argumentative design is a quest for grounded design decisions
- Design decisions should be justified through clear reasons and these need to be documented as an external memory and for later use
- The design process should not only produce solutions but also the arguments for the chosen solutions
- Argumentative design describes also different alternatives which were not chosen including the reasons for not choosing them
- Argumentative design creates a design space with alternatives and their different pro and con arguments
- The documentation is a tool for both design, evaluation and decision
- Argumentative Design brings implicit and taken-for-granted assumptions to the fore
- Argumentative Design makes the design and decision process transparent which is a condition for genuine participation and social rationality

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