

Towards Collaborative Web-Based Impact Assessment

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ABSTRACT

Impact assessment (IA) is a key method for the legislator to evaluate policies, norms or regulations currently under development. Experts use IA to gather and analyze input from many individuals to obtain clear problem statements, estimations regarding policies etc., and use this information to compare policy alternatives. Currently, the opinions, expertise etc. gathered for IA need to be structured by hand. Thus, the analysis steps of IA are time-consuming, and IA does not scale with the number of persons involved. In this paper, we introduce a collaborative approach for IA. Based on a Web 2.0 architecture, we let a community of individuals derive the potential, downsides and design alternatives of policies collaboratively. An important characteristic of our approach is that it guides individuals through the process of creating structured input. Our approach is fully implemented, and we have evaluated it together with legal experts using the structured-case method. While our evaluation reveals that the acceptance of web-based IA strongly depends on the user interface, it also acknowledges that our approach can be an important tool for future IA.

Categories and Subject Descriptors

H.4 [Information Systems Applications]: Miscellaneous

General Terms

Design, Legal Aspects

Keywords

Impact Assessment, Web 2.0 Application

1. INTRODUCTION

Impact assessment (IA) [9] is important to evaluate anticipated effects, unintended side effects and possible alternatives of norms, policies, regulations or laws. More precisely, IA is a quality-based approach where independent professionals as well as citizens concerned are asked for expertise and comments. Experts analyze this input in order to estimate the appropriateness of legal norms, to balance their positive and negative effects on society and to compare alternative policy options [9]. Thus, IA is a key instrument for the legislator to develop elaborate laws.

For this reason, IA is widely used in the EU. The *Commission of the European Communities* (EC) has declared in the “Better Regulations” package¹ that any major policy

proposal must be evaluated using IA. In 2008, the EC has commissioned 135 IAs [10] on legal norms regarding health care, consumer rights, nuclear safety, etc.² Further, the EC has established an independent IA board³ to supervise and evaluate IAs performed by other EC departments. In 2007, the board has examined 102 IAs [8]. This number has risen to 135 in 2008 [8], i.e., the EC strives to examine all IAs that have been commissioned.

For any IA, the topics behind the policies evaluated are complex. Thus, in order to obtain a full picture of the effects of the policy and of its alternatives, it is of utmost importance to consider the opinions and expertise of many professionals of the policy domain and of many citizens affected by the policies [9]. However, integrating many participants in the IA process is challenging. This is because different kinds of input have to be gathered from people with different knowledge and education in a way that allows for a structured analysis.

We have designed and implemented a Web 2.0 approach that lets a community of users participate in the IA process, without restricting the kind of information gathered. Our approach adopts topic maps to (1) collect and browse IA-relevant information, to (2) create references between related pieces of information, and to (3) support IA analyses. Our contributions described in this article are as follows:

- We introduce the roles *Expert* and *Participant* in the IA context, describe their tasks in the IA process and study their needs regarding a Web 2.0-supported IA tool.
- We develop a topic map which models the information collected and analyzed during the IA process. It can be extended by further concepts if necessary for a particular IA.
- We describe the design and implementation of a prototypical Web 2.0 application that allows a community of users to participate in IA, and that helps experts to analyze the information obtained.
- We evaluate our approach with the structured-case method. The evaluation confirms that our approach is useful for IA and provides suggestions for future research.

²http://ec.europa.eu/governance/impact/cia_2008_en.htm

³http://ec.europa.eu/governance/impact/iab_en.htm

¹http://ec.europa.eu/governance/better_regulation/

Paper outline: The next section features an overview of IA. Section 3 introduces our approach. Section 4 describes our evaluation. Section 5 concludes.

2. IMPACT ASSESSMENT

In this section we describe the fundamentals of IA, together with related work on IA. We then compile our requirements regarding system support for the IA process.

IA is a qualitative method to gather evidence on the effectiveness and possible impacts of policy proposals. Based on such evidence, IA derives quality measures for policy alternatives, e.g., the expected degree of goal accomplishment, possible side effects, the number of citizens affected, appropriateness, etc. Thus, IA provides the means [9] to systematically

- gather information from a wide range of independent stakeholders,
- provide a comprehensive analysis of impacts on sectors like society, environment or economy,
- identify the policy that meets the objectives with the fewest side effects,
- explain why a policy is necessary and appropriate, or, conversely, show why a policy should not be implemented.

Since 2002, the EC has completed over 400 IAs – alone 135 in 2008 [10]. The area of topics covered is broad⁴: A directive on the safety of toys has been analyzed as well as a regulation on motor-vehicle emissions. In 2007 three policy initiatives were stopped because IAs concluded that these policies were inappropriate [7]. Countries outside the EU use IA as well. However, as IA is a key method for the legislation process of the EU, the EC has spent the most effort in refining the IA process in the last years, including the establishment of an independent advisory board and mandating external evaluations [11]. For this reason, the definitions of the EC [9] are state of the art in IA and are used as a basis for our work.

2.1 IA Roles and IA Process

From the definition of the EC [9] we have extracted two distinct roles in the IA context: **Experts** carry out the IA process, i.e., they structure the information gathered and use it to assess different policy options. For example, experts can be politicians who want to make informed decisions. Experts work on IA documents like summary reports, which are compiled from information that is gathered from **participants**. Participants are professionals of the policy domain or independent stakeholders affected by the policy under investigation. Experts can (but do not have to) be participants.

IA consists of six steps [9]:

1. **Identify the problem.** Develop a clear problem statement. The basis of the problem statement is an intuitive problem description, e.g., a petition to the parliament.

⁴http://ec.europa.eu/governance/impact/practice_en.htm

2. **Define the objectives.** Specify the objectives needed to solve the problem. Based on this specification, investigate if the objectives are desirable. Methods to obtain the objectives include expert workshops and pilot studies.
3. **Develop main policy options.** Develop a number of concrete policy options from the preceding analysis of the problems and objectives. Furthermore, identify and eliminate inferior policy options when it is obvious that other options achieve the same or better results with fewer negative side effects.
4. **Analyze the impacts.** Estimate the impacts and side effects of main policy options regarding (1) sectors of general importance, e.g., impacts on social life, economics, or administrative overhead, and (2) sectors affiliated with the policy domain.
5. **Compare the policy options.** Compare the information obtained in the previous steps in order to identify policies which achieve the objectives envisioned without inappropriate side effects. To do so, the policy options must be compared how well they reach the objectives, and positive and negative impacts must be weighed against each other.
6. **Policy monitoring and evaluation.** The evaluation finds out if the policy proposal provides the intended effects. One evaluation option for the legislator is to pass an experimental law, i.e., a law with a revision clause requiring a re-evaluation after a defined period of time. Only if the law passes the re-evaluation, it will be made permanent.

The main criterion for the applicability of a certain policy option is the principle of proportionality⁵. In order to prove or disprove that a policy option complies with this principle, Steps 3 to 5 of the IA process collect and evaluate empirical facts.⁶

Example 1: In order to provide an intuitive example, we briefly outline the IA [5] for an EU directive to protect the soil [6]. The means to perform this IA have included stakeholder workshops where 400 participants were organized in five working groups, a public Internet survey, and a public consultation with 1,206 citizens, 377 soil experts and 287 organizations from 25 countries [6].

1. **Problem.** The soil is threatened by erosion, decline in biodiversity, sealing, pollution, landslides, contaminated water, etc., which do not stop at national borders. However, there is no EU-wide regulation.
2. **Objectives.** First, determine risks that arise from human activities and natural conditions, and identify areas at risk. Second, settle for supranational risk-reduction targets and measures to achieve them. Leave aside soil sealing, as this is already regulated elsewhere.
3. **Options.** Policy options are: (1) *Encourage EU members to protect soil by non-binding guidelines.* (2) *Specify all objectives and means for each soil threat at EU*

⁵<http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/ce321/ce32120061229en00010331.pdf>

⁶The German Federal Constitutional Court has emphasized the need for empirical facts several times [2, 3]. The same holds for other EU members.

level. (3) Define mandatory objectives, but leave it to the member states to transfer them to national law. The first two options were rejected in this IA step. The alternatives of the third option include the means to identify areas at risk, measure the risks, develop national protection strategies, establish soil status reports, etc.

4. **Analysis.** The analysis step identifies the costs, side effects and impacts of each option. To provide one example, the alternatives to find areas at risk are: (a) *Use existing monitoring schemes only.* (b) *Monitor any area in an EU-wide 16x16km grid.* (c) *Monitor progress in the identification of risk areas.*
5. **Comparison.** This IA step compares the alternatives for each policy option in isolation. When considering the alternatives to find areas at risk, Option (a) does not incur additional costs, but is less effective. Option (b) results in 97 million EUR over 50 years, while the costs for Option (c) are estimated to be significantly lower while being equally effective. Thus, the third alternative is optimal.
6. **Monitoring.** The final step of the IA for the soil protection policy has identified indicators for the objectives. Reporting obligations for specific measures are intended to provide an effective evaluation. For example, one obligation is that the progress of risk-area identification is monitored and evaluated. ■

The result of the IA process is a policy that has been carefully evaluated and refined. As a rule of thumb, the more people are asked for their contributions, the smaller is the chance to miss important impact factors. However, the sheer amount of information provided makes it difficult to involve a large community of users. In order to overcome this limitation, we strive for a software application that helps to gather, structure and analyze IA information.

2.2 Requirements for an IA Application

The requirements for an application that supports IA originate both from the specification of the IA process described so far and the need to involve many members of society who do not have in-depth knowledge on IA. We have identified six requirements:

- R1: Roles “participant” and “expert”** Because experts and participants have different tasks and skills, an important requirement is to provide them with mechanisms that are tailored to their role.
- R2: Structured knowledge representation** A structured representation of any information gathered during the IA process is required to organize and analyze the contributions of a large number of participants.
- R3: Analyses** In order to support the information needs of experts and participants during the analysis steps, a set of pre-defined queries as well as the means to browse and traverse the knowledge representation are required.
- R4: Collective intelligence** The participants might provide contributions that are misleading, contradicting, or biased by personal attitudes. Thus, editing and voting mechanisms are required to let the community sanitize the contributions.

R5: User guidance As the participants are not familiar with the complex IA process, the software has to provide intuitive and user-friendly interfaces to guide them through the IA process.

R6: Extensibility Since the IA process depends on the topics under investigation, the software needs to be extensible. Furthermore, experts must be able to adapt the knowledge representation without having to recompile the software.

We have decided to develop a web application based on these requirements for three reasons: (1) The Internet provides the means to address a large community of users, (2) web applications can be used through standard software installed on any PC with Internet access, and (3) the Web 2.0 technologies that are currently available ease the implementation of such an application.

3. A WEB APPLICATION FOR IA

This section describes our collaborative Web 2.0 application that assists in the IA process. In order to comply with the requirements identified in the last section, we will address the following building blocks:

- A data structure that represents the knowledge collected during the IA process (Requirement **R2**).
- The functionality available to role *Participant* (Requirement **R1**). This includes support (a software-“wizard”) to guide participants through the process of collecting relevant information (Requirement **R5**) and an editing/voting system (Requirement **R4**).
- The functionality available to role *Expert* (Requirement **R1**), i.e., the functions for the participants together with the means to search, browse, structure and evaluate the information gathered, and to extend the knowledge representation (Requirement **R6**).
- A set of pre-defined queries that help to execute general IA analysis steps (Requirement **R3**).

In order to realize these building blocks, we have analyzed IAs of the past, documentation of IA and court decisions, together with a German law firm specialized on environmental law. We cannot guarantee that we have not overlooked aspects important for future IA. However, experts can adapt our representation, and extending a web application is relatively simple (cf. Requirement **R6**). Furthermore, it is part of our evaluation to identify functionality that might be missing. Regarding architecture and implementation, our prototype follows a standard client-server architecture with a database backend and is using AJAX for a responsive user interface [14].

3.1 Knowledge Representation

The six analysis steps for IA imply that it is good practice if a participant, when proposing a new measure, provides the following information: (1) describe the *measure*, (2) link the *measure* with the *objective* it is intended for, (3) state how *measure* and *objective* comply with the principle of proportionality, and (4) point to *experiences* like studies, facts or anecdotic evidence. Thus, a knowledge representation for IA must systematically manage policies, objectives, measures, problems, impacts, juridical concerns, etc. (**R2**). Furthermore, the representation has to model relationships between

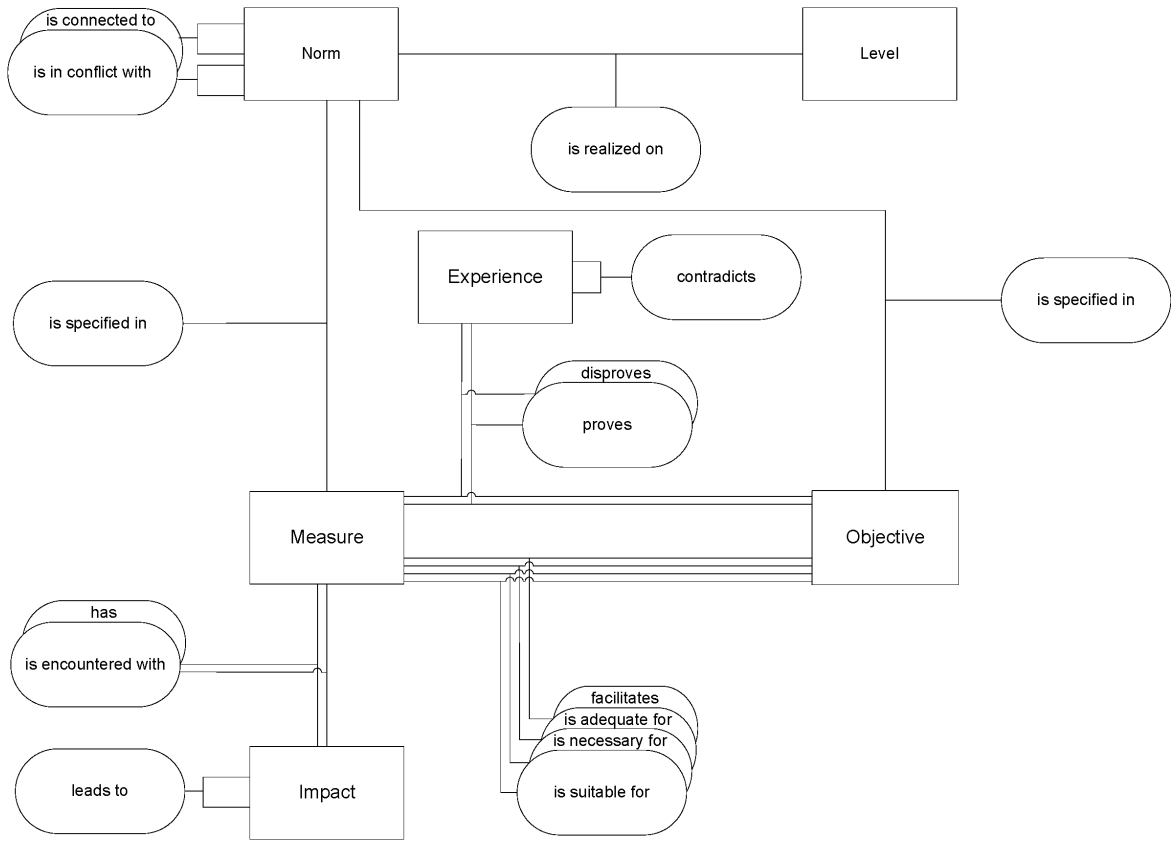


Figure 1: The topic map for IA.

those aspects, e.g., which measures are planned to reach a certain objective, or which objectives have been specified for a particular policy option. Finally, the representation must allow structured access to this information (**R3**). It must be possible to issue queries to find out how policy aspects are linked to certain impacts, and how a policy option affects another one.

We have realized our knowledge representation on the basis of topic maps. Topic maps [15] are an ISO standard [12] for ontologies that humans can easily understand, browse and navigate. The building blocks of topic maps are **topics**, **associations** and **occurrences**. All three building blocks can be typed and have instances. Topics describe an object or aspect that exists in the real world. If a topic is typed, it is called **topic type** and describes common characteristics of an object set. An instance of a topic type is called **instance topic** and refers to a certain object. Associations establish links between topics. **Association types** describe one certain relationship between topic types. Occurrences link to external resources outside of the topic map.

We map IA information to a topic map as follows: Topic types and association types provide a structured classification for statements and contributions. These types are domain-independent, i.e., they are the basis for any IA. When participants provide domain-specific information for a particular IA, they create instances of topic types, association types and occurrence types.

Figure 1 visualizes our model. The model has been obtained from the consistent IA argumentation structure of the EC [9], which implies the model components. Rectangles represent the topic types, and association types are boxes with round corners. Edges connect the topic types linked by a particular association type. As each topic type and association type can have instances and occurrences, they are not shown in the figure for better visibility. If future IAs required further types, experts can extend or modify the model (Requirement **R6**, cf. Subsection 3.3). Our model includes the topic types Norm, Level, Objective, Measure, Impact and Experience. A **Norm** represents a policy proposal, law, regulation etc. The **Level** describes at which administrative layer a norm will be implemented (European, national, communal, etc.). **Objectives** represent the goals of a norm. A **Measure** is any action that might help to realize these objectives. The **Impact** stands for intended and unintended effects of a measure. Finally, **Experiences** provide evidence that a certain measure helps to reach a particular objective. Bi- and trivalent association types connect the topic types specified. The association type “disproves” links an experience, a measure and an objective such that, according to the experience, the measure does not help to reach the objective. Association type “proves” in turn stands for a positive proof. Two experiences can be contradicting (“contradicts”). The principle of proportionality requires that a measure “facilitates”, “is suitable for”, “is necessary for”, and “is adequate for” an objective. The objective “is specified in” a norm. A measure often “has” an impact, and it is possible that it

“is encountered with” another measure. Sometimes an impact “leads to” another impact. A measure “is specified in” a norm. Two norms may be connected or contradicting (“is connected to”, “is in conflict with”). Finally, a norm “is realized on” an administrative level.

Example 2: To provide the intuition behind our approach, we exemplarily show how a detail of Example 1 is represented in our context. The policy proposal for soil protection [6] specifies an obligation to create a status report of the soil when selling a site. With our representation, this corresponds to an instance of “Measure”:

Instance name	Description	Topic type
Status report	Either the seller or the buyer of a potentially contaminated site provides the transaction partner with a soil status report.	Measure

Figure 2: An instance of “Measure”.

The goals of this measure are represented as instance topics of type “Objective”. One of the objectives mentioned is to satisfy public interest, which is mapped to our knowledge representation as follows:

Instance name	Description	Topic type
Public interest	The obligation to transmit information on the soil status improves and accelerates the identification of contaminated sites.	Objective

Figure 3: An instance of “Objective”.

The topic instances “Status report” and “Public interest” are linked with an instance of the association type “facilitates”. All other aspects mentioned in the proposal for soil protection can be mapped to our representation in a similar way. ■

3.2 Support for Participants

Now we specify the functionality needed by the role *participant*. Participants have to provide new arguments in favor of or against certain policy options and shall be able to link existing arguments to others. When looking at our knowledge representation, this corresponds to creating new topic instances, providing relationships (association instances) between them and linking external documents as instances of occurrence types. Furthermore, participants must be able to browse the topic map in order to review, extend and correct existing instances. Thus, our web application has to provide the following set of methods for participants:

- Browse the topic map.
- Search for topics and associations.
- Create and edit instances of topic types, association types and occurrence types.

According to Requirement **R5**, the participants cannot be expected to know the IA process in detail, and our system has to guide them through the creation of meaningful

IA-relevant contributions. The standard approach to guide users through a web application is to provide a “wizard”, i.e., a sequence of web pages that collect the information required in consecutive steps. Since creating new instances of topic type “Measure” is one of the most frequently used functions, our Web 2.0 application implements a wizard that asks the participants for all information required for this purpose. This includes statements how well the new measure complies with the principle of proportionality, and which objective the measure is intended for. We have identified the following consecutive processing steps the participants must fulfill to create meaningful instances of topic types and relationships between them regarding new measures:

1. Specify a new measure.
2. Link the measure to an existing objective. Alternatively, create a new objective and create a link to the measure.
3. Provide a statement on how the measure complies with the principle of proportionality, i.e., if
 - (a) the measure is suitable to achieve the objective,
 - (b) there is a milder measure available to achieve the same objective,
 - (c) the measure is in proportion to the importance of the objective.

Besides the wizard for new measures, other wizards might be useful as well. For example, another frequent action is to specify new objectives. Here, the participants identify promising measures and link experiences to indicate that these measures might help to meet the objective.

Figure 4: Wizard step 1.

Example 3: Figure 4 shows the first step of our wizard where the participants provide details about a measure. With the information obtained from this page, the wizard creates the instance of the topic type *Measure* shown in Figure 2. ■

3.2.1 Editing/Voting

Participants might provide contributions that are misleading, contradicting, or biased by personal attitudes. This limits the number of participants of current IA, as experts are needed to filter these contributions. In order to tackle this issue, Requirement **R4** calls for mechanisms that allow

the community to control the quality of the contributions provided by the participants. To be precise, we require a way to determine if updates to the topic map should be applied or not. For example, if a participant tries to correct the description of an objective but fails to make a significant improvement, this change should not be applied. The system to deal with changes also has to protect contributions from vandalism, e.g., participants deleting information on a contribution they do not agree with. Every valid point of view should co-exist, to let experts see all aspects of a law.

When looking at the Web, two approaches are commonly used for voting: Either a group of designated users makes the decision, i.e., they moderate what is applied and what is not, or the community at large takes a vote. In order to unburden the experts from structuring and examining all information provided, we have opted for voting. A simple voting mechanism is to let the community provide binary votes in favor of or against a certain change, and to make the change persistent only if the majority of users have voted positively in a certain period of time. This voting mechanism is applicable in large community-driven databases, e.g., MusicBrainz⁷. We have implemented this voting mechanism for any action that modifies existing information, i.e.,

1. Change the name of a topic.
2. Change the description text of a topic.
3. Dissolve a type-instance relationship.
4. Change the name of an association.
5. Change the description text of an association.

Changes that generate new data objects, e.g., creating new topic instances of “Measure”, are applied immediately.

For each modification that invokes the voting mechanism, our application generates an **Edit**. The edit describes who wants to change which element at what time and in which way. Figure 5 shows an edit open for vote.

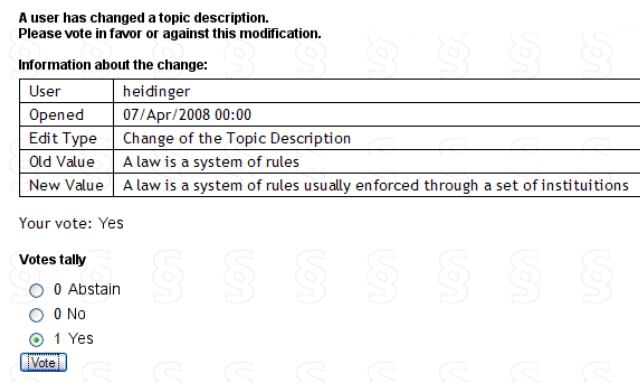


Figure 5: A change that is up for a vote.

The upper part displays information on the modification, the lower part shows the interface elements that let the users vote.

Other voting approaches might be applicable as well. For

⁷<http://musicbrainz.org/>

example, Discogs⁸ uses an approach where designated moderators control any changes. For more sophisticated voting mechanisms see [1].

3.3 Support for Experts

The task of the IA role *expert* is to draw conclusions on contributions and statements created by participants, i.e., experts have to search, browse, structure, augment and analyze the information gathered. As the experts might also be specialists of the policy domain, functionality available to any participant is also available to them. Experts also make corrections, e.g., if they find misclassified contributions. Furthermore, experts might have to adapt the knowledge representation to the needs of future IAs (cf. Requirement **R6**), i.e., they need to modify each aspect of the building blocks Topic, Association and Occurrence. Thus, our web application has to provide the experts with the following set of methods:

- Browse the topic map.
- Search, create, modify and delete
 - topic types, association types, occurrence types,
 - topics instances, association instances and occurrence instances.
- Generate overviews, i.e., present lists of all topics together with the types and instances associated.
- Execute queries that perform recurring IA analysis steps (cf. Section 2).

The next subsection will describe the queries needed for analyses.

3.4 IA Analyses

As Section 2 has shown, the IA process includes analysis steps, e.g., an expert has to check for facts that indicate or disprove the suitability of a measure regarding a certain objective. Our knowledge representation allows to implement those analyses as pre-defined queries on the topic map. With our knowledge representation, there is an association linking objective, measure, and facts (e.g., a scientific study). Thus, a query can identify all objective-measure associations which are not linked with a fact. Together with experts from a law firm we have identified four queries which are repeated on a regular basis in any IA process:

- *What are the objectives?* (Step 2 of the six analytical steps described in Subsection 2.1.)
- *What are the measures intended to accomplish the objectives?* (Step 3.)
- *What are the facts that support a measure-facilitates-objective relationship?* (Steps 3 to 5.)
- *What are the measures where no facts indicate that the measure will accomplish its objectives?* (Steps 3 to 5.)

Note that these queries do not cover every information need. However, any other information can be obtained by browsing the topic map, and the web application can be extended for further queries (Requirement **R6**).

⁸<http://www.discogs.com/>

4. EVALUATION

The objective of our evaluation is to find out the following: (1) Does our collaborative approach provide good support for experts gathering and structuring information from participants? (2) Is the functionality implemented sufficient for the tasks participants and experts have to carry out in the IA process?

Since IA is a qualitative method to systematically collect evidence on complex topics, its outcomes cannot be measured easily in quantitative terms (cf. [16]). Instead, we need a qualitative evaluation. We have used the *Structured-Case* [4] (SC) method to improve and evaluate our approach. SC is an iterative process where each iteration results in a critical reflection of the issues learned, together with a set of improvements for the next iteration. The iteration stops if the informative value of the results is sufficient. In the following, we briefly sketch the fundamentals of SC, and we provide a description of our first and second SC iteration.

4.1 The Structured-Case Method

SC represents the iterative nature of building theory from qualitative data by using a formal process model consisting of *conceptual frameworks* and a pre-defined *research cycle*. The conceptual framework represents the aims of the researcher, his understanding and theoretical foundations. The research cycle consists of four stages which the researcher repeats until his research goals are met:

Plan Develop a course of action (plan) by deriving appropriate use cases, target groups and evaluation methods from the conceptual framework.

Data Collection Gather and record data according to the plan. Do some initial analysis to find out which supplementary information has to be collected.

Analysis Structure and analyze the data collection guided by the concepts of the conceptual framework, and develop new concepts and themes.

Reflection Critically review the research process and scrutinize the analysis results in order to avoid to only confirm findings that have been expected. Adapt the conceptual framework for the next iteration.

We have conducted two SC iterations. During the first SC iteration, we have developed an operational prototype, together with a concept for a thorough evaluation. The second iteration evaluates our approach and provides information on future work.

4.2 The Initial Conceptual Framework

We start the SC process with a conceptual framework that reflects our central idea of enhancing the IA process by Web 2.0-style user collaboration. We can declare success if typical IA users regard our approach positively, the requirements we have identified are meaningful for IA, and our approach meets these requirements. Thus, our conceptual framework builds on the working hypotheses that

H1: experts appreciate obtaining a structured set of contributions from a large community, instead of structuring the evidence and facts gathered from a comparably small set of participants by hand,

H2: the requirements identified in Section 2 are sufficient for a collaborative IA web application, and

H3: the knowledge representation as well as the components of our approach, as described in Section 3, provide the experts and participants with the means to collect and structure IA information.

Furthermore, the framework includes literature on the fundamentals of the IA process and case studies carried out with IA (cf. Section 2).

4.3 The First Research Cycle: Preparation

Before describing our evaluation in the second research cycle, we will briefly summarize our preparations, which were done in the first cycle. This cycle has to identify the means for a thorough evaluation. Furthermore, it has to refine our prototypical implementation for this purpose. Therefore, we have conducted a pilot study with IA experts from a law firm that develops software to manage environmental obligations of large companies. Thus, our experts are familiar both with IA and software solutions for legal problems. We have based our pilot study on test data from the proposal for a EU directive on soil protection [6]. We summarize the results of the first SC iteration as follows:

- Our approach seems to be sound, and our prototype is ready for an evaluation at a larger scale.
- The user interface of the wizard needs some changes to ensure that information flows are transparent for the participants.
- Jurists with an expertise in IA are a relevant target group for our evaluation.
- Because it is very well documented, the draft of the German *Renewable Energy Sources Act* [13] is an appropriate test case for a thorough evaluation.

4.4 The Second Research Cycle: Evaluation

After having identified a test case and a target group for evaluation, and after fine-tuning our prototypical implementation, we have started the second SC iteration to evaluate our approach.

Plan. The target group of our collaborative IA approach are experts gathering evidence on policies. Thus, we have to evaluate our approach with individuals who are likely to spend some time on training regarding the IA process and the use of IA tools. For this reason, we evaluate our approach with three lawyers who are familiar with our prototype from the last SC iteration. Our method of research is an IA case study, followed by a questionnaire and interviews. According to the results of the first SC iteration, we will use a draft of the German *Renewable Energy Sources Act* [13] as a test case. This act makes it obligatory to use renewable energy sources when constructing new buildings or carrying out major restorations on old ones.

In order to find out if our collaborative IA approach provides good support for experts when gathering and structuring information from participants, our experts have to find out if the information provided is represented properly, and if the underlying knowledge representation allows to execute an

IA analysis based on the various statements and the relationships between them. Therefore, it is part of our plan to let our lawyers act both as experts and as participants. In particular, we assign each lawyer one of the roles “house owner”, “representative of the association for the protection of tenants” and “environmentalist”, and we let them gather evidence and facts according to their roles. The roles provide controversial opinions on this specific draft. For example, house owners are likely to be unwilling to spend money on renewable energy sources, while environmentalists strongly prefer renewable energy sources over the traditional ones. After collecting information and opinions according to these roles, the lawyers had to follow the “experts”-role in the subsequent IA processing steps, as described in Section 2.

Data Collection. We have scheduled one day for an introduction to the test case, two weeks to execute the IA test case with our prototype, and a number of days to do interviews and answer an online questionnaire. Our questionnaire⁹ consists of 30 questions targeting at the usability of our prototype in the IA process as well as at the appropriateness of our requirements and at the power of our knowledge representation to structure IA-relevant statements. The questionnaire covers the following seven aspects:

General questions: What is IA? How much experience do you have with IA? Have you participated in IAs so far?

IA test case: Describe the role you have played in the test case and state the user name used to log into the web application.

Structured contributions: How do you rate the structured knowledge representation in general? How useful is the set of topic types and association types we have devised? Name advantages, disadvantages and open issues.

Guidance for participants: How well does the interface for participants – and in particular the wizard – guide through the IA process? Are there important aspects of IA that are not covered by the wizard?

Editing/voting: Do you think the editing and voting system is effective in ensuring high-quality contributions? Did you see any flaws in the voting system?

Analysis: Do the pre-defined queries provide all information needed for the IA analysis? If this is not the case, what is missing?

Usability: How do you rate the usability of our web application for the roles “expert” and “participants”? Which way of entering contributions do you prefer, and why?

In order to obtain meaningful indicators, we let our experts either answer in plain text or provide marks on a five-point Likert scale. Since we were interested in objective results, we put much attention to ensuring that our questions do not imply a certain answer. In addition, we have conducted extensive interviews with each expert to learn the rationale behind their answers, e.g., why certain features of the application have been regarded as more useful than others.

Analysis. After having executed the data-collection step, we have analyzed the information obtained. In the following, we summarize the findings compiled from the interviews and the data submitted through the questionnaire. We relate these findings to the working hypotheses from our initial conceptual framework.

H1: Structured set of contributions Our experts have appreciated to obtain structured information from the very beginning. In particular, they have found it very useful to find related information by browsing the topic map, instead of having to file large amounts of unstructured data manually. However, our study participants did criticize that the web application does not enforce this structure. For example, some participants wrote all related information into the description field of a measure, instead of generating and linking a topic type “Impact”. We conclude that our knowledge representation is sound, but more of the functionality needed by participants should be implemented in a wizard style.

H2: Satisfaction of requirements We have to verify if our study participants agree with our requirements, i.e., if the implementation of our requirements results in a useful IA application.

R1: Roles “participant” and “expert” The differentiation between participants and experts has been regarded as very useful. This is important, as the functionality for experts is complex and needs a comprehensive understanding both of the IA process and of the knowledge representation. We cannot expect this from participants.

R2: Knowledge representation The study participants agree with our structured representation of the information collected and evaluated during the IA process. In particular, they did not want to adapt the knowledge representation, and they did not find any IA-relevant information that could not be mapped to the knowledge representation.

R3: Analyses The queries pre-defined to ease repetitive IA analyses were deemed useful or very useful on the Likert scale of the questionnaire. On the other hand, some experts mentioned that analyses beyond these pre-defined queries were complicated, because they required going through several steps using the interface for experts.

R4: Collective intelligence The idea to let the community review changes in order to improve the contributions of the participants was considered to be useful or neutral. Our study participants found it confusing to have some changes accepted or rejected without being able to know who voted in favor or against the modification.

R5: User guidance The wizard to guide inexperienced users through creating topics and associations in a sequence of steps was considered useful to very useful. This is in line with our findings regarding Requirement **R1**.

R6: Extensibility Because our experts did not find missing IA topics (cf. our findings for Requirement **R2**), they did not use any functions to modify and extend the topic map. However, our experts agreed that it is very useful to be able to adapt the knowledge representation if necessary.

⁹<http://www.ipd.uka.de/~heidingc/IA/Questionnaire/>

H3: Applicability of our approach Since our evaluation was based on a real test case, we have shown that any information from an entire IA process can be mapped to our knowledge representation. Our study participants were able to make their contributions with ease, and they could perform all IA analyses and processing steps in the role of experts.

To sum up, the questionnaire and the interviews have revealed that the user interface needs to be more intuitive. Since experts might need to modify the knowledge representation according to the needs of future IAs, we have to put more attention to a thorough training for experts. Furthermore, in order to avoid faulty entries made by inexperienced users it is important to implement more functionality as wizards. In particular, this is true because even the experts found the concept of a topic map difficult to understand. Finally, a refined version of our application should make the voting system more transparent. On the other hand, our approach seems to be sound and should serve as an important contribution towards involving a large community of participants into future IAs. Our prototypical web application is operational, and was deemed helpful by experts for IA.

Discussion. When reviewing the first two research cycles, we find that our method of research has provided us with an operational prototype, a comprehensive model of the knowledge gathered during IA, and strong indications that our approach helps to involve a large community of users into the IA process. The next research cycle must involve tests on a larger scale, i.e., with more users providing more contributions. This is important, since our small number of study participants has been insufficient to stress the collaborative editing/voting mechanism. Furthermore, the next research cycle should force the experts to use the functionality provided to modify the topic map.

5. CONCLUSIONS

Impact assessment is an important tool for the legislator to pass elaborate laws, policies, norms or regulations. Experts collect a lot of information from specialists of the regulation domain, stakeholders and individuals concerned. Currently, IA is a manual process where experts have to evaluate unstructured sets of opinions, expertises or statements.

In this paper, we have introduced a collaborative, web-based approach that supports the collection and evaluation of IA-relevant knowledge. In particular, we have analyzed the requirements, the nature of information important for IA, and the contributions collected during public IA consultations. Based on this information we have developed a knowledge representation to classify and link statements, opinions and expertises. We have devised a Web 2.0-based IA approach that provides a wizard-style user interface for inexperienced users, pre-defined queries to support repetitive IA analysis steps, and editing/voting mechanisms to let the community of users improve the contributions stored. Finally, we have refined and evaluated our prototype together with juristic experts by using the structured-case method. According to our evaluation, our system might be an important step towards involving a large community of users in future impact assessments.

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