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Using GSS For Decision Reconstruction: A Preliminary Study

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Abstract

The importance of understanding the reasons of past decisions is not a new subject. However, there seems to be a gap regarding the verification of the efficiency of tools for understanding past decisions. In this paper we posit that the ability to perform decision reconstruction, using a GSS solution, can provide a flexible solution to the problem, but only if the information model underneath it is able to support/structure both ways the phases of a decision-making process. Based on earlier work, we present a first proposal for a general information model to support the decision-making process, as well as the decision reconstruction process. We tested these ideas by setting a case study where we used a prototype, based on a proposed model, to analyze a simulated public contracting process and present a discussion based on the obtained results.

Keywords: *Decision Reconstruction, GSS, Information Model*

1 INTRODUCTION

Distributed decision-making comes as a natural consequence of the virtualization of organizations and the geographical dispersion of the decision agents (Power & Sharda & Kulkarni 2007). By virtualization we mean the process of incorporating information and communication technologies and their exploitation towards strategic goals (Kim & Son & Kim & Kim 2008, Strader & Lin & Shaw 1998, Venkatraman & Henderson 1998). In this context, group support systems (GSS) are a natural solution for the demands of the distributed organizations when it comes to support decision processes (Bafoutsou & Mentzas 2002, Dennis & George & Jessup & Nunamaker & Vogel 1988, DeSanctis 1993, DeSanctis & Gallupe 1987, Nunamaker & Dennis & Valacich & Vogel & George 1991). GSS are recognized to facilitate knowledge acquisition (Kwok & Ma & Vogel 2000), improve decision quality and quantity, enhance participant satisfaction (Dennis & Haley & Vandenberg 1996), and reduce the cost and length of meetings, though larger groups appear to benefit more than smaller groups (Vreede & Vogel & Kolfschoten & Wien 2003). As an introductory remark we will address GSS, throughout the paper, using a broad concept (as presented in Arnott & Pervan 2005), in which such systems are seen not only as a communication support, but also a decision enabler technology, supporting the different stages of a decision process. Such stages are: 1) the identification and listing of all the alternatives (intelligence phase); 2) the determination of all the consequences resulting from each of the alternatives (design phase); and 3) the comparison of the accuracy and efficiency of each of these sets of consequences (choice phase) (Simon 1977).

Based on earlier work (Antunes 2007, Antunes & Costa & Maçãs 2005, 2006, 2008a, 2008b) we present in this paper a first attempt towards reaching a general information model to support decision-making processes, as well as decision reconstruction processes of past decisions. We posit that establishing relationships among group discourse elements with relevant meta-data provides the necessary information to perform decision reconstruction, as well as to visually structure and represent a GSS-based discussion. In order to test our early ideas we set up a case study using a prototype, based on the proposed model, to analyze a simulated public contracting process. Although the research is still on its early stages, we point out some interesting results.

In section 2, we frame our research problem according to previous literature. To overcome the detected problems we define the constructs for a decision reconstruction in section 3, as well as the details of the proposed model. In section 4, we present the case study, namely its settings, methodological groundings and the discussion of the obtained results. We dedicate the last section to final remarks and future research considerations.

2 DECISION RECONSTRUCTION

The importance of understanding the reasons of past decisions is not a new subject, whether for knowledge or for auditing purposes (Maier 2004, Turoff & Chumer & Hiltz & Klashner & Alles & Vasarherlyi & Kogan 2004a, Turoff & Chumer & Van de Walle & Yao 2004b, Turoff & Hiltz & Bieber & Fjermstad & Rana 1999a). For instance, a system with decision reconstruction capabilities seems particularly adequate in public contracting, as it would support decision agents (from public sector) in the process of reaching decisions and it would also help applicants to reconstruct such decisions, helping them to understand the processes and even to detect possible manipulations in real time. We stand that this aspect would help in enhancing transparency and reducing corruption (as stated in Danielson & Ekenberg & Grönlund & Larsson 2005, Stirton & Lodge 2001), empowering GSS as tools for public consultation and external scrutiny of decisions. Such considerations are stated in the European Transparency Initiative (Commission of the European Communities 2006), as well as in the SOX. Such legislative actions put pressure to organizations in order to register every aspect that is related to decision-making, namely its intervenients, and organizational role, documents, process steps and even tasks that may not have started yet, easing future audits (Turoff 2006, Turoff *et al.* 2004a, Turoff *et al.* 2004b).

However, related research seems to have been directed to build and use visualization tools and not so much to verify the efficiency of such tools in understanding past decisions. Research on expert systems also expresses the concern for explaining (rebuilding) decisions, embedding it into the explanation subsystem (Turban & Aronson & Liang 2005), though the specificity, normative character and development costs of such systems do not quite seem to fit the needs of collaborative work. We posit that the ability to perform decision reconstruction, using a GSS solution, can provide a more flexible solution to the problem. However, this can only happen if the information model underneath it is able to support/structure the collaborative discourse (as defined by Turoff & Hiltz & Bieber & Fjermstad & Rana 1999b), thus supporting the decision process from phase 1 to phase 3 (Simon 1977), as well as the reverse process (from phase 3 to phase 1).

A GSS solution should be, therefore, able to encompass a multiplicity of approaches when it comes to support different ways of building a collaborative discourse (according to Turoff *et al.* 1999a). Such ways range from the simple question-reply pattern to more elaborated ones, usually supported by argumentation theory and its constituting elements (Conklin & Begeman 1989, Gordon & Karacapilidis 1997, Gordon & Voss & Richter & Märker 2001, Rinner 2001, Singh & Genesereth & Syed 1995, Streitz & Hannemann & Thüring 1989, Turoff *et al.* 1999b).

We define decision reconstruction as the process that allows an individual or group of individuals, whether internal or external to the organization, to understand how a GSS supported group previously reached a decision. We also comprehend decision reconstruction in *lato sensu*, meaning that the utility of the construct fits the needs of the organization's internal users, as well as the external and usually independent examiners, commonly known as auditors. We find the decision reconstruction concept preferable to a decision-auditing concept, as audits (internal or external) carry some mistrust connotation or even the intention to appraise whether a past decision was indeed the best solution.

GSS are built upon the idea of sequential support of the decision-making phases defined by Simon (1977). The consequence of this observation is that after settling a solution or decision, it is not always an easy task to understand the earlier stages of a discussion. This is particularly notorious at the end of the discussions, when created classes encompass the discussion elements. Probably there are many occasions were the sole review of discussion topics and produced decisions are enough to recall the details of such decisions, especially to decisions agents that were involved in it. Still, as those decision agents may no longer be in the organization, we stand that anyone should be able to retrieve that information easily. In such a case, the GSS should allow the possibility for in-depth examination whenever required.

Beyond the ability to structure and support group interaction in different modes of group work, we find that more properties are needed when the goal is decision reconstruction. One of the problems in decision reconstruction is the incapacity to extract the details of a discussion, especially if those details are "flattened". For instance, in a GSS voting environment, it is usual to expect the initial votes to change as a part of the group process (Turoff *et al.* 1999b). Nevertheless, even if people are allowed to review their votes (for instance, after group discussion), when the decision is made and results are exhibited, the final report is deficient in evidencing the progresses, changes of opinions (and by who, if possible), convincing arguments, etc., which were made from the initial state of the discussion to its ending. In this case, a new group iteration (seen, for example, as the moment of changing a vote) substitutes the earlier one, discarding the previous discussion scenario.

3 A MODEL FOR DECISION RECONSTRUCTION IN GSS

We posit that a general GSS information model for decision reconstruction needs to be able to register (document) the in-between steps of the convergence/consensus building. This type of behaviour resembles the capabilities of entity-based versioning systems. Such systems can create versions of packages, classes, and even individual methods of a complete system, during its entire lifespan (Robbes & Lanza 2005). This fine-grained ability to version several types of elements fits the needs of our model, as it allows to perform an in-depth registration of different elements (discussions, topics, convergence procedures, etc.).

Another perquisite of our model is the possibility to link information among discussions, as GSS usually organize discussions independently, though having the possibility for "copy/paste" of older contributions into a new discussion. The loss of that association creates a barrier for decision reconstruction. We stand that though "copy/paste" mechanisms are easy to use, they should not only present a duplicate of the information, but, and more important, a link to the discussion where it was originated.

We describe the proposed behaviour (structuring, versioning and discussion linking) in Figure 72. In order to preserve the readability of the figure, we only described the incorporation of information of different discussions, using their results. However, any contribution could be associated to different discussions.

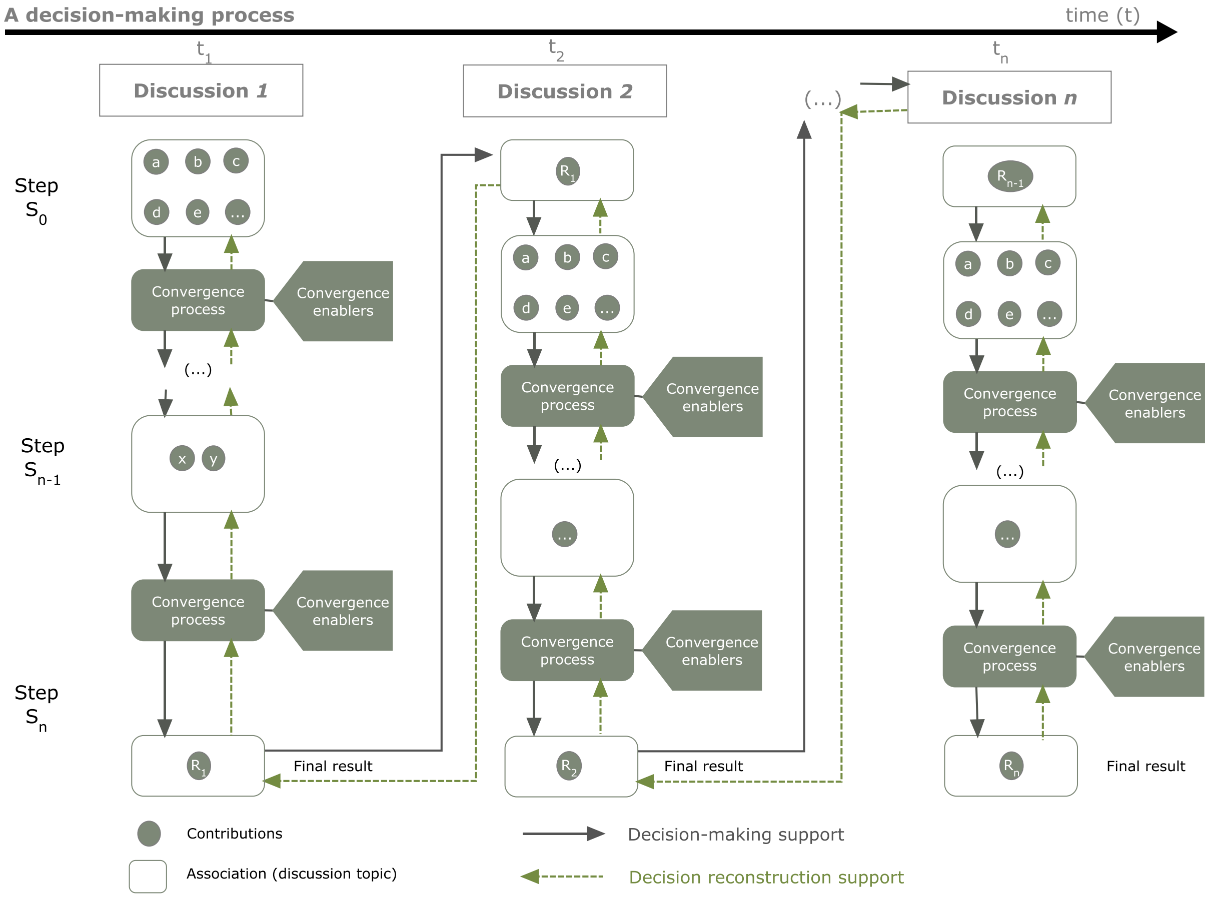

Figure 72. Information behaviour

In the particular case of supporting discussions regarding public contracting, a system based on the proposed model needs to guarantee that information cannot be deleted, to preserve the transparency of the process. Instead, contributions need to be marked as "active" or "inactive", in order to be considered in the group analysis (as an inactive contribution represents a "deletion" but without information loss). In Figure 73, we present the proposed model, as well as its abstract components. We describe the components of the model and its relationships in the next subsections.

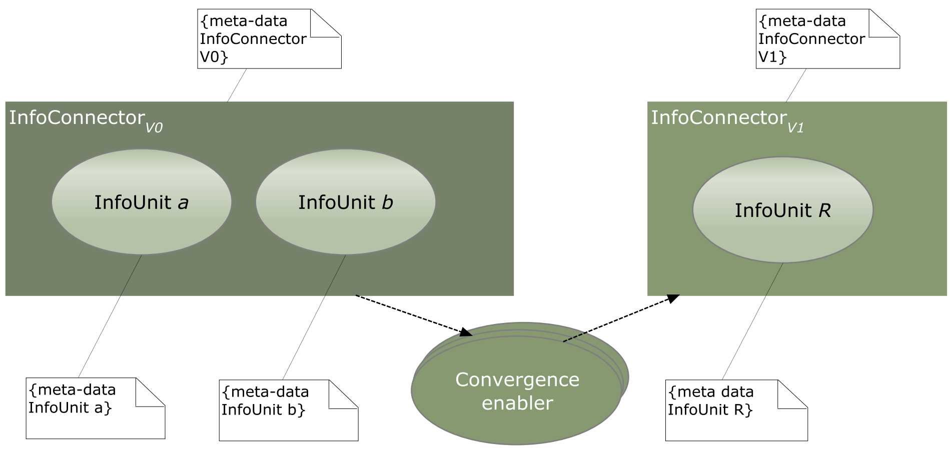

Figure 73. A general information model for GSS decision reconstruction

3.1 InfoUnit

The *InfoUnit* is the core of the information model, as every other element depends on its existence. Its main objective is to receive the group's contributions and to store them for future recall. As different types of discussion may require different types of entries from the group, this element needs to be adequately specialized, according to a concrete problem. As the group's participants are also a part of the problem to be addressed, *InfoUnits* should also be specialized to represent users and their roles during a discussion, such as arbitrators, mediators, negotiators, facilitators, etc. (as regarded in Kersten 2004).

3.2 Meta-data

The meta-data hold a dynamic list of properties, automatically generated when creating *InfoUnits* and *InfoConnectors*, ranging from automatic indexing information, such as identification, authoring, time stamping, etc., to individual information (Losee 2006), such as personal annotations or measures for defining the affective value of information objects (Lopatovska & Mokros 2008). That sort of information provides the elements needed to establish categorizations in order to deepen contextual information and to help users to understand, use and extract information, while narrowing possible information ambiguity (Lee 2004). *Meta-data* also constitutes the bridge to fill in the gap of usual GSS towards argumentation theory. As different discussions may require distinct argumentation structures, *Meta-data* can be specialized in order to encompass different argumentation models. As it is not possible to create *InfoUnits* without associated *Meta-data*, *InfoUnits* will always comply with the selected argumentation model or template, thus enhancing the possibilities for faster and richer decision reconstruction, as the usual thread pattern of GSS does not have to be the ground of collaborative discourse. Associating *Meta-data* to *InfoUnits* provides the necessary information for meaningful classifications to enhance the possibilities for visual representation of the discussions.

3.3 InfoConnector

An *InfoConnector* is the "glue" that establishes associations among *InfoUnits* (and their Meta-data). The specialization of this element not only allows establishing a multiplicity of links in order to capture the relationships among *InfoUnits*, which can belong to different *InfoConnectors*, but also enables *InfoConnectors* to act as information containers (discussions, topics, categories, etc.). *InfoConnectors* can also establish relationships among other *InfoConnectors*. Some types of relationships among *InfoUnits* or *InfoConnectors* can be: response, dependence, version, merging, etc. This information element is also responsible for establishing the context of *InfoUnits*, as they are responsible for establishing constraints (validation rules) to *InfoUnits*, so that the information of the *InfoUnits* remain coherent within a defined context, thus enhancing the possibilities for reuse and integrate the information. These rules are associated with the type of data that each *InfoConnector* supports. As it happens with the *InfoUnits*, the creation of *InfoConnectors* implies the creation of associated *Meta-data*.

3.4 Convergence Enabler

As different group discussions may require distinct strategies to achieve convergence (consensus, or agreements, also known as collaborative grounding (according to Hertzum 2007), the *Convergence Enabler* is responsible for implementing the convergence method, or methods, to be applied, for each *InfoConnector* that holds *InfoUnits*. The *Convergence Enabler* needs to be specialized in order to encompass existing converging techniques adequate to the problem (statistical analysis, mathematical algorithms, multi-attribute utility theory, multi-objective linear programming, restructurable modelling, game theory, non-linear optimization (Kersten & Lai 2007), ThinkLets (Briggs & Vreede & Nunamaker & Tobey 2001), or any other method of automatic or computer guided nature), or developing new convergence methods. When automatic procedures are not suited for achieving convergence (Antunes *et al.* 2005, Dourish 1995, Rinner 2001), *Convergence Enablers* can incorporate manual convergence methods, such as voting, manual selection, or some other kind of collaborative convergence (Helquist & Kruse & Adkins 2008). The *Convergence Enablers* are also responsible for recording the used convergence methods for future reuse.

3.5 A tool for implementing the model

In order to integrate the described ideas, we adapted a prototype from earlier research. Such system relies on the idea of discussions performed by a previously registered group (the discussion group). It encompasses three different, and sequential, working environments (see Figure 74): a structuring editor (that structures the group's interaction), a visual map tool (that visually represents the discussion elements) and a document production environment (where is possible to create a document from the discussion elements).

Figure 74. The sequential process of the prototype

Discussions, which take place in the structuring environment, represent *InfoConnectors*. Each discussion has topics, also *InfoConnectors*, which receive group contributions in the form of numbers and text, which represent *InfoUnits*. There is also a chat tool associated with each discussion topic. To aid the consensus building process, the system also provides a tool for analyzing group divergence, which implements divergence resolution methods (though in our study only voting and leader selection are available). The interactions of the consensus building process are organized and represented as versions (or steps) of the different discussion topics. The system also associates *Meta-data* to every discussion, topic or group contribution (meaning *InfoConnectors* and *InfoUnits*) to associate authoring, time stamping and personal classifications to them.

The visual map tool retrieves the discussion elements as a set of networked components, providing an interactive environment for people to explore, discover, analyze and tap into information (as intended by Zhang & Nguyen 2005). Users can change the default representation, but such changes only affect the visual arrangement of the elements and not the represented information objects.

The system also produces structured documents derived from the defined information structures, which represent the discussions, topics, numbers and texts (once again meaning *InfoConnectors* and *InfoUnits*), without the need for specialized computer skills. To do so, dragging the references to the objects from the structuring environment into the document is required. With this process, the system creates automatic links that point to where the generation of the objects took place. Then, if needed, users can change the text of the automated links to build the document. When a user activates a link, the system traces back the object in the structuring environment, which allows the user to reconstitute the context and the reasons that led to the creation of the said object. The edit tool has two different views: the declaration view and the normal view. The former view allows working with the information structures and editing the document, while the latter view shows the documents as an ordinary word processor, mainly for printing purposes.

4 CASE STUDY

To gain further knowledge on the information requirements regarding a GSS approach for decision reconstruction in public contracting, we set up a case study to determine the suitability degree of the proposed model to the question in hand. This case has a twofold objective: firstly, it is a preliminary study to determine if decision agents are able to use the tool comfortably (tool testing objective) and secondly, to determine if the proposed information model meets the needs of decision reconstruction (model testing objective). We call this a preliminary study because we wanted to gain a more informed insight of the problem in the field, before actually testing the solution (tool and model) in real life public contracting decision processes.

4.1 The case setting

The problem in hand regarded a past decision for contracting an auditing firm in a public company, according to national legislation requirements. We set up a simulated decision process supported by our GSS prototype. We divided the discussion into different discussion topics, where group discussion took place. We simulated the contributions, the presented financial elements for each competitor, as well as their proposals regarding the price and time for executing the task, as well as the consensus processes that led to the result.

As a control element, we introduced a biased voting process when discussing the weight of the factor price of the proposals, as the group leader (the mediator) unilaterally selected the referred weight, when the group was not able to solve their differences, to avoid delays. This situation had an impact on the selected competitor (final decision). By introducing such control mechanism, we wanted to observe whether the discussion elements allowed the subject group to obtain the necessary information to detect that the final decision could have been another.

The case study scenario emulates the need for understanding the referred decision-making process by a decision agent that was not involved in the process. To do so, we asked seven persons (the subject group) to analyze the discussion, in order to study whether they would be able to reconstruct the decision process, according to the information provided. These persons were superior technicians of a research institution with both management and group support systems usage experience.

After analyzing the situation using the prototype, we asked each member of the subject group to fill in a short questionnaire to evaluate both the tool and the information model. In the first part of such questionnaire, all of the group members rated several measures for two units of analysis presented in the next subsection. In the second part, all of the members were also asked to write a detailed description of the situation, in order to assess the accuracy of the decision reconstruction, by confronting the descriptions to our previously set-up situation. We also asked the participants to write their opinion about the prototype tools, taking into consideration the measures they rated in the first part of the questionnaire.

4.2 Methodology

Methodologically, our research is framed by the process of design research (Hevner & March & Park & Ram 2004, March & Smith 1995). This option takes into consideration the creation and the study of the use and performance evaluation of artefacts in order to understand, explain and improve information systems. There are many descriptions (and diagrams) about the design research process in information systems (see, for instance, the ones described in Cole & Purao & Rossi & Sein 2005, Gregg & Kulkarni & Vinzé 2001, Hevner *et al.* 2004, March *et al.* 1995, Vaishnavi & Kuechler 2004/5). However, we adopt the process defined in Peffers & Tuunanen & Gengler & Rossi & Hui & Virtanen & Bragge 2006). We make such option not only because it is an eclectic approach, which combines the research steps of other authors (namely Eekels 2000, 2001, Hevner *et al.* 2004, Nunamaker & Chen 1990, Rossi & Sein 2003, Takeda & Veerkamp & Tomiyama & Yoshikawa 1990, Walls & Widmeyer & El Sawy 1992) but also because it emphasizes knowledge use and development along the research.

The first iteration of the case study (according to the research process proposed by Peffers *et al.* 2006) focused on applying a GSS prototype, to fit the proposed model and to demonstrate the feasibility of the proposed solution (Nunamaker *et al.* 1990, Vaishnavi & Kuechler Jr. 2008). The second round of the case study required explanatory work or observational testing (Hevner *et al.* 2004, March *et al.* 1995, Yin 2003), for which we developed two units of analysis to be evaluated: structuring capability and storytelling capability.

The first unit allows measuring the ability to structure a group's discussion. To accomplish this goal we decomposed this unit into several others:

- Contribution posting (of argumentation elements and procedures);
- Relationship management (to perform changes and register alterations of the established relationships among argumentation elements);
- Structure awareness (to evidence the structure of a group's discourse, as well as the performed changes);
- Idea transmission (to elaborate on complex ideas using the defined argumentation elements and posting procedures);
- and Documental elaboration (to produce structured documents based on the argumentation elements).

The second unit of analysis – storytelling capability – allows measuring the ability to retrieve information from previous discussions. This unit of analysis depends directly on the performance of the measures obtained in the first unit, meaning that low quality regarding discourse and document structuring will probably have a negative impact on discourse storytelling. We decomposed this unit into:

- Structure storytelling (to retrieve a discourse from the structural representation of the argumentation elements used within a discussion);
- Documental storytelling (to retrieve a discourse from the visual representation of the argumentation elements used within a discussion, using the visual map tool);
- Cognitive load (to retrieve a discourse combining the use of the structuring environment of the developed GSS, with the use of the visual map tool);
- and Haziness avoidance (to avoid vagueness attributable to issues that are not clearly defined using the argumentation elements and procedures).

4.3 Results and discussion

All the elements of the subject group were able to correctly understand and describe the decision process. Although we did not initially consider the time for completing the task in the case study scope, we found out that each group element took about 45 minutes to learn how to use the tool and to apprehend the fundamentals of the decision process. When answering the questionnaire, specially the free writing part, all the elements needed to reuse the prototype to remember or verify particular issues. The fast and recurrent reuses of the tool were not registered, but they probably explain the accuracy level of the seven descriptions regarding the decision process.

The questionnaire answers (first part) are not statistically relevant and we chose not to present them in detail (or the questionnaire itself). However, the obtained results for the different sub-units of analysis were around the middle of the used scale ("reasonable") and quite identical for all involved. Much more relevant for our goal is the second part of the questionnaire, where we invited the subjects to write down their opinion on the used tools and processes to reconstruct the decision process. Based on the answers, we accounted four different processes of reconstructing the decision process:

- Start by using the document production tools to analyze the produced documents and using them to jump into the structuring environment for details;
- Start by using the visual map tool to visually analyze the structure and then occasionally jumping to the structuring environment;

- Start by using the structuring environment for the details of the discussion and then jumping to the visual map tool in order to easily get “big pictures” of the relationships among the elements;
- A hybrid approach using all the processes (e.g. start by using the document production tools for some part of the reconstruction process and to start by using another working environment for other parts).

Note that each of these (first three) decision reconstruction processes directly connects to one of the working environments and represents a different cognitive behaviour of the group subjects. Each of them complained about the lack of re-structuring tools for the decision process information (argumentation elements and other data) allowing for his/her own way of analyzing the past situation. To overcome this problem some of the participants suggested re-structuring tools. They also complained that the existent tools and the modelling possibilities of the prototype are maybe excellent on supporting several ways for conducting a decision process, but this freedom of style hindered the decision reconstruction process.

5 FINAL REMARKS AND FUTURE RESEARCH

The importance of understanding the reasons of past decisions is, nowadays, of utmost importance. The European Transparency Initiative, as well as the SOX Act, clearly states such considerations. In this paper, we presented an information model that is able to support a GSS to perform decision reconstruction. We tested this model, implemented in a GSS prototype, by setting a case study in order to analyze and reconstruct a simulated public contracting process. The case study was able to show the capability of the information model to register and recover relevant information for rigorously understanding a past decision process focused on public contracting. However, participants considered missing some important reconstruction tools in the prototype.

The GSS prototype had two main goals: on one hand to fully support a decision process accommodating several ways or forms of conducting, by allowing a very flexible structuring and argumentation environment and, on the other hand, to fully support the decision process reconstruction with a minimum of cognitive load. We found that these two objectives are somewhat opposed: too much freedom of style on the decision process makes its reconstruction harder. We need further studying to achieve a balance between these two objectives. Although the information model presented in this paper supports both objectives, the particular tools used in a GSS implementing the model needs careful calibration in order to achieve this balance.

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