KEDGE BUSINESS SCHOOL
ILS2016
Information Systems Logistics and Supply Chain
6th International Conference
université de BORDEAUX

Decision theaters: a creative approach for participatory planning in the forest sector

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Abstract. This paper explores past and current developments and applications of decision theaters and discusses their potential benefits for participatory planning in the forest sector in Québec. A participatory mechanism involving the users of forest resources and the territory is illustrated through three regional cases studies. We identify the main challenges and discuss how decision theaters can contribute in addressing them. The next steps of our research are finally presented.

Keywords: decision theaters, participatory planning, stakeholders, forest resources management.

1 Introduction

Decision-making can be a complex task. Notably, when the problem to deal with is ill-defined, decision makers are overwhelmed with data, decisions to be made are subject to high uncertainty, the decision process involves the participation of multiple stakeholders, etc. Involvement of stakeholders is frequently observed in public participatory planning (e.g., town-hall meetings, public forums, advisory comities, etc.) where the community's members who have a stake in the issue are invited to share their concerns and perspectives and take part in the decision process. Examples are found in environmental management [1], [2], urban planning [3], natural resources management [4], [5], etc. As a part of their social responsibility, companies have also to manage their relationships with their stakeholders and take into account their concerns [6].

What makes decision-making complex when multiple stakeholders are involved is that, usually, the stakeholders come from different backgrounds, and therefore, they are likely to have very different values and interests. As a result, a given solution may be beneficial to some of the stakeholders, but disadvantageous for the others [7]. The stakeholders may also have heterogeneous and different levels of knowledge, and their perceptions might be as important as facts [8].

It is argued that the results of decision processes relying merely on formal assessment techniques and in which the analysts are in full control of decision support raise equity, trust, and representativeness issues among stakeholders [2]. In fact, stakeholders may expect to be offered the possibility to evaluate alternative options from the perspective of their interests, knowledge, preferences, and value-driven criteria, and may also wish to contribute to problem analysis and solution generation [7], or even to problem definition [1], [2]. To this end, the stakeholders need an easily understandable presentation of information and easily usable interaction facilities [7]. Stakeholders who have difficulty in understanding maps and scientific information displays may also need a detailed view of alternative solutions and background information or even customized visualizations that help them to figure out the consequences of a given alternative [3], [7], [8].

Traditional decision support tools such as OR models are not designed for dealing with these situations. Thus, there is a need for new approaches enabling the combination of visualization and decision modeling capabilities together with human capacity of insight and interaction. Decision Theaters (DTs) is one of these approaches. They can be viewed as meeting rooms (real or virtual) characterized by specific input/display technologies and seating arrangement that allow a group of people to interact with each other and with the data in order to contextualize a decision-making situation, evaluate the impacts of decisions, and find a common solution (an example of a DT configuration is shown in fig. 1).

This paper explores the concept of DT and discusses its potential benefits for participatory planning in the forest sector in Québec. In fact, more than 90% of the forests in Québec are public-owned, which leads to the coexistence of various users of forest resources (e.g., forest companies, First Nations people, recreation activities providers, trapping permit owners, etc.) in the same territory. As a consequence, disagreements usually arise among users, leading furthermore to severe disputes. In 2013, a new forest

regime entered into force and introduced specific participatory planning mechanisms in order to mitigate these disagreements and harmonize the uses. However, the implementation of these participatory mechanisms in real-life met a limited success. The remainder of the article is organized as follows: the next section introduces the concept of DT and presents an overview on past and current developments. Section 3 describes the participatory planning mechanisms introduced by the new regime in Québec with a special emphasis on Local Panels dedicated to forest management planning involving the users of the forest territory. It also provides the results of implementing the Local Panels in three different regions and highlights the main challenges. Finally, section 4 discusses the potential benefits of using DTs in addressing these challenges and presents the next steps of our research.

2 Decision theaters: a literature review

DTs can be linked to different concepts in military, politics, education, research, and business. The term "decision theater" was used in the 70s [9] to designate a new teaching approach in marketing decision-making. A laboratory called "Decision Theatre" was built at Our Lady of the Lake University of San Antonio. It was used as a learning facility for management students and as a research tool in decision-making and organizational research [10]. More recently, Arizona State University has built a DT in Tempe, Arizona (2005) (fig. 1). Another DT has been built by the McCain Institute for International Leadership in Washington D.C. (2013). These two DTs together form the Decision Theater Network [11].

Figure 1: A decision theater built at Arizon State University (Decision Theater Network [11])

Other universities such as University of British Columbia, Huazhong University of Science and Technology (China) and Tecnológico de Monterrey (Mexico) have all built DTs. These DTs are often referred to as *semi-immersive environments* due to their specific configuration and display technologies (e.g., panoramic wall displays) that allow catching participants' attention, for instance through real-scale 3D image displays. As an example, the DT in Tempe, Arizona (fig. 1) has a core physical component called the "Drum", which is a round room with seven screens arrayed across 260 degrees that can display models, panoramic computer graphics or 3D video content. It also provides capacity for audio and video recording as well as tools for collecting data from participants [12]. Due to recent advances in information and communication technologies, DTs can also be extended to virtual meeting rooms, and accommodates remote participants.

Preparing a plan for disease outbreaks; assist policy makers and stakeholders in understanding the socio-economic implications of different energy extraction investment options; explore how the effects of climate change on natural resources could contribute to political instability are some examples of research projects conducted within the Decision Theater Network at Arizona State University [11]. However, the scientific literature does not provide sufficient information on how the DT is being used to conduct these projects: Edsall and Larson (2006) [13] and Larson and Edsall (2010) [14] described a study in which the effects of visual information technology on public understanding of groundwater management in the desert metropolis of Phoenix (Arizona) were evaluated. The study compared a 3D demonstration in the DT to a parallel 2D Power Point presentation in a standard classroom. Based on a water management model called WaterSim, which was presented in the DT of Arizona to a group of decision makers and stakeholders, White et *al.* (2015) [5] studied the perception and understanding of participants of uncertainty. In a similar study, White et *al.* (2010) [12] investigated the decision makers' perceptions of the credibility, salience, and legitimacy of WaterSim model.

Research conducted in the Landscape Immersion Laboratory (LIL) at University of British Columbia aims at investigating, in community planning context, the effects of visualization technologies and semi-immersive environments on the public' ability to understand and evaluate possible forest management alternatives and landscape planning scenarios. Regarding forest management, a visualization system linking together forestry modelling programs and a 3D rendering engine was developed and implemented at LIL [4], [15]. This visualization system allows orchestrating the flow of large amount of data needed for creating accurate portrayals of forest landscapes based on high-level policy decisions [4]. Meitner *et al.* (2005) [4] reported that this visualization system enabled researchers to see forestry modelling outputs in new ways and helped them to detect errors and evaluate the models limitations and assumptions.
The visualization system was used in public forums in the context of interdisciplinary research projects in sustainable forest management. It was found that the visualization aspect was helpful, as it tends to make the modeling outputs more relevant to the average attendee. Sheppard and Meitner (2005) [16] described a pilot study conducted in southeastern British Columbia, where one of the research questions was whether spatial models and visualization technologies were effective in participatory planning, and what impact these tools have on the results. Two forest harvesting scenarios were prepared and evaluated in three different ways. First, experts were asked to evaluate the two scenarios against a set of sustainability criteria. Then, different groups of stakeholder were asked to provide their preferences for the same set of criteria. The stakeholders' preferences were used to weight the evaluations of the experts. Finally, the direct preferences of the stakeholders were obtained by using realistic landscape visualization supporting scenario descriptions. Although similar results were obtained for all three evaluation methods, it was reported that over 90% of participants found the visualization helpful [16].
Concerning landscape planning, Salter *et al.* (2009) [3] explored the abilities of LIL's immersive display environment and CommunityViz; a GIS based decision support system that includes a semi-realistic and interactive landscape visualization capabilities, to improve participant understanding of residential density policies. The authors described two workshops held at LIL facility where three land use alternative plans were presented to the participants. It was reported that the ability to dynamically explore the visualizations of the plans and see real-time changes in indicator metrics were considered by the participants particularly informative, and appeared to increase participants' understanding of the plans. In particular, the visualizations allowed the participants with less knowledge to better understand the residential density policies and to contribute to the discussion [3].
In military, politics, media, and business, specific terms such as war room can be linked to DT concept. In military and politics, a war room can refer to an intelligence analysis center, an operations center (also called command and control center) [17] or a situation room [18]. Most of the research in military on war rooms tries to address the question of how to improve the situation awareness of a team working in a time-sensitive operations context in order to make quick and informed decisions. In particular, some studies focus on the design of large wall screens used to display information in order to support shared situation awareness and improve battlespace visualization [19], [20], and [21]. Other research projects grouped under the name "command center of the future" have been lunched in the 1990s in different countries with the aim of designing new arrangements for command and control centers by taking advantage of the development of new information technologies [22].
For instance, the FOCAL project at Australia's Defence Science and Technology Organization is based around an SGI Reality Center and provides a large virtual reality display environment. It implements a multi-agent architecture to enable interaction, information retrieval and processing, information synthesis, and display. Available works in the literature on FOCAL project describe the development of a user interface used to support "natural" interaction between users and a virtual geospatial display [23] and the conceptual design and prototype development of virtual planning rooms [24]. The ROLF 2010 project conducted at the Swedish National Defence College at the request of the Swedish Armed Forces develops concepts based on the assumptions that seating arrangement would facilitate communication among staff members, and the use of data available from different sensors jointly with advanced technologies to present the data would facilitate the situation awareness of the staff members [25].
In business, the war room approach is viewed as "a very focused, intense effort to organize complex programs, to develop programs and strategic plans, and to visualize and assimilate data and linkages between information that impact multidimensional plans" [26], [27]. Shaker and Rice (1995) [27] argue that the war room provides a solution to information overload and visualization problems. Evidence Based Research, Inc. (EBR), Connective Management and N.E.T. Research are examples of companies developing and implementing war rooms for companies. The management cockpit war room is another type of "business war room" [28]. It is based on human intelligence (e.g., information processing capacity by human brain) and management processes principles and uses information technologies and ergonomic

room design to improve the productivity of a management team. The management cockpit war room is inspired from the scorecard principles. It enables displaying information formalized as questions and answers related to the company's resources, the extent to which the objectives are reached, the obstacles the company faces, and the decisions that should be made to achieve the objectives.
Another concept related to war rooms and DTs is GDSS (Group Decision Support System) [29], [30]. This term appeared in the literature in the 1980's. It refers to "an interactive computer-based system which facilitates solution of unstructured problems by a set of decision makers working together as a group" [29]. Four components are attributed to a GDSS; hardware (input/output devices, common viewing screens or individual monitors displaying information to the group, etc.), software (data bases, model bases, user interfaces, etc.), people (decision makers, facilitators, etc.), and procedures (e.g., verbal discussions, flow of events, etc.) [29], [31]. These components are arranged to support a group of people, typically in the context of a decision-related meeting [31]. Jelassi and Beaclair (1987) [30] described the main contributions in this area in the 80's. More recent works focus on consensus assessment in multi-criteria and group decision-making contexts, by using mainly mathematical models [32], [33].

- **Discussion**

The use of DTs and other related concepts in different domains proves their relevance as a decision-making approach for various problems, going from very short to very long term planning. They appear particularly relevant for dealing with decision problems involving multiple decision makers/stakeholders or for data overload issues. However, the literature does not provide enough information for implementing a "DT approach" as the decision process can hardly be reproduced.
In military, acquiring situation awareness is related to the short cycle of decision-making inherent to command and control, which are time-sensitive operations. Thus, research on long term and mid-term planning is not the main focus and existing research focuses more on technology and human-machine interaction and less on "human-human" interactions and decision-making process. As in military applications, business war rooms are used to enable the decision makers to understand the current situation and decide on future actions. What is new is that war rooms are rather used for strategic or making decisions on regular basis. Here, the literature emphasises less on technology and human-machine interaction aspects, but there is still limited information on the decision-making process.
More recent research focuses mainly on very long term planning involving policy makers and the public (participatory or community planning). Again, there is a lack of information on the decision-making process. Moreover, experiments involving the participation of stakeholders limit considerably their actions since they don't actively take part in the decision-making process. In most cases, the participants are shown predefined plans and/or landscape visualizations (e.g., 2D and 3D images) and they are asked to give their feedback on what they perceive and understand through questionnaires, discussions, etc. But, as discussed previously, the stakeholders may expect to be involved in the early stages of the decision process. This is in fact the case for two participatory planning mechanisms observed in Québec.
As a conclusion, more research needs to be done in the area of DTs. In particular, it is not clear how decision makers and other participants in the DT interact with data, with decision supports systems and with each other, and how each actor contributes to the process of problem definition, analysis, and solution given his/her background knowledge, perceptions, values, etc.

3 Participatory planning in the forest sector in Québec

3.1 Participatory planning mechanisms under the new regime

Under the new regime, the Ministère des Forêts, de la Faune et des Parcs du Québec (Ministry of forests, wildlife and parks, hereinafter referred to as MFFP), is responsible for planning the public forests. Two plans are prepared at the Forest Management Unit (FMU)[1] level; the *tactical integrated management plan* and the *operational integrated management plan*. These plans must be coherent with the orientations of the sustainable forest management strategy, the public land use plan, and the regional plans for integrated development of resources and territory, defined at the provincial and regional levels [34]. The tactical plan is prepared for a planning horizon of five years. It specifies the allowable cuts assigned to an FMU or group of FMUs, the sustainable forest management goals for the FMU, the locations of main

[1] An FMU is a geographic forest area, which supplies mills holding timber supply guarantees in the FMU's territory.

infrastructures (e.g., forest roads) and areas of intensified fiber production, and the forest management strategy for the FMU. The operational plan specifies the harvesting areas and forest roads and other infrastructures to develop in a horizon of 1-3 years [34]. Both plans are prepared in collaboration with the *Local Integrated Land & Resource Management Panel,* hereinafter referred to as Local Panel, and the *Operational Panel*. These two panels together with *Public consultations* and *First Nations people consultations* are the main participatory mechanisms under the new regime.
The aim of the *Operational Panels* is to align the forest certification requirements of forest companies holding timber supply guarantees (i.e., license owners) requiring a forest certification with the forest management strategy and optimize wood procurement plans. The *public and First Nations people consultations* allow the broad public to express their concerns regarding the two plans.
A *Local Panel* is established by the regional authorities for each FMU or group of FMUs in a given region. The main goal is to ensure that interests of the users of forest resources and the territory are taken into account during the planning process [34], [35]. The Local Panels are constituted of representatives of license owners, First Nations band council, environmental institutions, recreation activity providers, trapping permit owners, etc. MFFP planners and experts and representatives of the regional authorities as well as invited researchers, consultants, etc. also participate to the Local Panels. A facilitator ensures the animation of the meetings while a coordinator is responsible for organizing the meetings.
In this study, we focus on the Local Panels. Based on the forest planning manual (version 5.1)[2], we identified the main planning activities involving the Local Panels.
At the tactical level, the Local Panel participates in identifying the areas of intensified fiber production as well as parts of existing forest roads to develop in the long term to provide multi-resources uses. The Local Panel's members also describe the users' concerns related to forest management and determine the most important issues. Next, issues requiring similar solutions are grouped together and potential solutions for addressing them (i.e., forest management strategies) are proposed. The economic, environmental, and social impacts of these solutions must be evaluated. Experts are invited to support MFFP planners and the Local Panel in this iterative process. It ends when a consensus is reached among the Local Panel members. A table presenting the issues, objectives, indicators and their targets (VOIC card) is then prepared. VOIC cards are used as a tool to monitor the implementation of selected solutions: specific objectives are derived from the solutions, and indicators as well as targets are defined to measure the achievement of the objectives [34].
At the operational level, MFFP planners select potential harvesting areas for the next five years respecting the management strategy and VOIC targets, while license and harvesting permit owners prepare accordingly a five-year plan for forest roads and other infrastructure development. Both plans are presented to the Local Panel, which may require changes. MFFP planners select a sub-set of potential harvesting areas for the next 1-3 year, which must respect the management strategy and VOIC targets as well as efficiency targets defined in collaboration with the Operational Panels. The selected harvesting areas are presented to the Operational and Local Panels, which may require changes. Next, license and harvesting permit owners refine the forest road and infrastructures plan for the next 1-3 years, and the plan is presented to the Local Panel.

3.1 Evaluating the success of implementing Local Panels in Québec

- **Regional case study 1: Bas-Saint-Laurent**

In Bas-Saint-Laurent, six Local Panels were established (one panel for each FMU), but later, they have been merged into three sub-regional panels (East, Center, and West). To evaluate the satisfaction of persons who participated to these Panels, the regional authorities conducted a survey in 2013 [36]. The evaluation was based on 19 meetings between 2010 and 2013. A questionnaire was distributed to 84 participants. 27 responses were returned.
First, it was reported that the progress was long and traditional conflictual positions still exist. In fact, the majority of respondents mentioned that their concerns were not effectively taken into account. For instance, it was stated: "we are still waiting to see our concerns taken into account". It was also mentioned that the voting mechanism was not effective and seen as divisive. In this regard, many respondents indicated the absence of real consensus about some topics. The VOIC cards have also been criticized by some of the respondents. The lack of impact analysis and information availability at the right time, and the existence of contradictions among VOIC cards were pointed out as the main issues.

[2] The forest planning manual is produced by MFFP. It describes how the tactical and operational planning processes should be implemented under the new regime [34].

However, it was recognized that VOIC cards helped in finding consensual solutions in some cases, even though some issues were not fully treated or postponed due to the lack of information/proofs, or in order to avoid conflictual situations.
The respondents were in general satisfied with the facilitators, but some respondents asked for additional skills and more objectivity. Information and expertise provided by MFFP was also satisfying. However, some participants asked for a diversified expertise, for example, by inviting experts from other ministries. Finally, the majority of respondents reported that due to the Local Panel meetings, they now better understand the concerns of participants from other areas of interest.

- **Regional case study 2: Mauricie**

We conducted an interview in December 2015 in Mauricie with three experts (two from MFFP and one from the regional authorities) who played an active role in implementing and operating the Local Panels in the region. Five Local Panels were established at the beginning (one for each FMU), but two of them merged. At the moment of writing this article, a new restructuration is being undertaken by the regional authorities. All four Local Panels will be merged into one Regional Panel, and will deal with regional issues, while working comities will be formed to deal with local issues at the FMU level.
The three experts reported that real consensuses were extremely difficult to achieve. The main reasons mentioned were that confidential agreements were in some cases committed between participants outside the Panels; some participants were not willing to participate to the discussions or clearly stay their opinions (e.g., participants who don't feel confident with their "low" knowledge level); some participants had to align with the views of persons or organization they represent regardless of their own views and willingness to collaborate; and, in some cases, two sub-groups having differing views were formed inside the Panel, and this resulted in extreme inconsistency among goals and the impossibility to find compromises.
In this regard, the experts mentioned that some economic objectives such as maximizing timber harvesting were not even consistent with the ecological constraints defined by the sustainable forest management strategy. The most conflicting issues were related to forest road planning, wildlife habitat, and the landscapes. It was also reported that many participants did not trust the scientific knowledge and information presented to them, but relied solely on their perceptions. Finally, as in Bas-Saint-Laurent, VOIC cards were recognized to be useful in some cases, but the lack of information and impact analyses was pointed out as an issue.

- **Regional case study 3: Capitale Nationale**

A similar interview was conducted in December 2015 with an expert from MFFP who contributed to the Local Panel implementing and operating in Capitale Nationale.
The expert explained that 50% of the participants had difficulty in understanding information presented to them due to their relatively low knowledge level. Thus, an effort was made by MFFP planners to overcome this hurdle, by continuously providing comprehensive explanations and arguments. The expert reported that overall, the Local Panels were successful. She mentioned that the VOIC cards were useful and consensus could be reached in most cases. She added that the participants were very satisfied and the comments following public and First Nations people consultations were positive. According to her, what contributed most to the success of the Local Panels in the region was the opportunity of social networking among participants, prior to the formal Local Panel meetings. In fact, a field visit was usually organized the day before the meeting, and this led the participants to familiarize themselves with specific issues, acquire awareness, and connect with participants from other areas of interest.

4 How can decision theaters benefit forestry participatory planning in Québec?

As shown in previous section, Local Panels were successful in Capitale Nationale, but they met a mitigated success in Bas-Saint-Laurent while in Mauricie, the results were rather disappointing. This can be partially attributed to the characteristics of each region; for example, in Mauricie, there is a wide diversity of forest resources users compared to Capitale Nationale or Bas-Saint-Laurent which makes it more difficult to reconcile different interests. There are also differences in regional initiatives. In Capitale Nationale for example, the field visits prior to Local Panel meetings have proven very useful, since they played a major role in connecting people, which furthermore, led to enhancing participants' willingness to collaborate during the meetings. Similar field visits were reported in Bas-Saint-Laurent and they were

appreciated very much by the participants [36]. This helped them to better understand others' concerns and interests. By taking advantage of DTs' immersive capabilities, virtual field visits can be easily created, through for example, videos or 2D and 3D images projected on the walls.
Information availability was identified as a major issue in Bas-Saint-Laurent and Mauricie. In Bas-Saint-Laurent, the lack of information often led to interrupting or postposing important topics, which led furthermore to the impossibility of adequately treating the issues and achieving consensuses among participants. In Mauricie, the interviewed experts indicated that the majority of participants would have appreciated visualizing the results of a given solution. According to one of the three experts, many participants claimed: "I would like to see what it looks like!" This would certainly improve the impact analyses (VOIC cards), which were pointed out as another issue in Bas-Saint-Laurent and Mauricie. Robert (2013) [36] argues that descriptive data and information localized in data bases, maps, websites, etc. would have a substantial impact on the quality of discussions and the ability to solve problems. In Capitale Nationale, a substantial effort has been made by MFFP planners to enable participants with low knowledge level to understand the information presented to them, and this was worthwhile.
Within DTs, the planners can do even better since DTs offer the possibility to visualize data in different ways (maps, data bases, websites, videos, charts, etc.) as well as the possibility to interact with data (e.g., exploring a landscape by using a realistic 3D map, from different perspective and observing distances, or challenging the parameter values of a decision support model, see for e.g. [3] and [4]). It provides also the capability to display large amount of data in an "optimized" way, by exploiting the configuration of the wall displays (e.g. in fig. 1, the cascading effect of a decision can be displayed from the left screen up to the right screen). This can help to figure out the effect of an assumption or a decision (e.g. a timber harvesting strategy) on multi-dimensional indicators (e.g., volume of harvested timber, ecological impacts, scenic beauty, etc.) at different stages of the value chain and time horizons (see for example [37]), and identify trade-off solutions. Such a problem was pointed out as a major research challenge in forest planning [38]. A direct benefit for participatory planning observed in Québec (i.e. Local Panels) is the possibility to provide a more comprehensive impact analysis and, thus, improve the VOIC cards.
Immersion, interaction with technology, and data visualization among others offer new opportunities for decision makers, stakeholders, planners, etc. to make better decisions in decision-making situations that traditional decision support tools cannot address alone. However, one should see these "technological" capabilities as enablers, which would be useful only if a well-structured decision-making process is used as the main frame. We refer to this as "staging in the DT". Staging means identifying the different steps leading to the final decision, from problem identification to the selection of a solution with the help of DT's technological capabilities, as well as identifying which and how each actor (planners, stakeholders, facilitators, etc.) participates at each step. We believe that multi-criteria decision support principles combined with "best practices" of participatory planning observed in real-life or recommended by the scientific literature and international standards can help in defining this staging process. Multi-criteria theory in particular was identified as a promising approach for dealing with forest planning problems involving multiple criteria and multiple stakeholders [38]. In our future work, we intend to:

- Identify the best practices for participatory planning.
- Based on these best practices, multi-criteria theory principles, and DT's technology capabilities, propose a general framework describing the staging process in DTs for participatory planning.

Acknowledgement

We acknowledge the financial support of NSERC discovery grant program and the Canada research chair program.

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