Technological Forecasting & Social Change 117 (2017) 70–83

Contents lists available at ScienceDirect

Technological Forecasting & Social Change

Evaluation of a visual analytics decision support tool for wind farm placement planning in Alberta: Findings from a focus group study

Ovo Adagha [a,c,*], Richard M. Levy [a,c], Sheelagh Carpendale [b,c], Cormack Gates [a], Mark Lindquist [d]

[a] Faculty of Environmental Design, University of Calgary, 2500 University Drive, Calgary, Canada
[b] Department of Computer Sciences, University of Calgary, 2500 University Drive, Calgary, Canada
[c] Computational Media Design Program, University of Calgary, 2500 University Drive, Calgary, Canada
[d] School of Natural Resources and Environment, University of Michigan, 440 Church Street, Ann Arbor, MI, USA

ARTICLE INFO

Article history:
Received 9 May 2016
Received in revised form 1 January 2017
Accepted 5 January 2017
Available online 24 January 2017

Keywords:
Decision support
Visual analytics
Focus groups
Stakeholders
Evaluation
Wind energy
Land-use planning

ABSTRACT

In socially-embedded tasks like planning the location of wind farms, certain evaluation methods have been used to establish the viability of decision support tools. These methods often consider the usability and technical functionality of decision support tools, users' tasks, and other important characteristics. However, such evaluations provide only a partial assessment of the prototype design process because the perception of usefulness, ease of use on tasks, and common barriers to use, from the point of view of the people who use the tool, are not always sufficiently integrated. The study in this article employs the focus group methodology to evaluate AB–WINDEC – a place-specific decision support tool designed to match the socio-technical requirements of stakeholders involved in wind farm placement planning in Alberta. In this context, the main purpose of the focus group was to elicit real-world perspectives from stakeholders who will eventually use the tool. The results of the study suggest that AB–WINDEC can be useful for educational purposes, public engagement, high-level analysis, risk assessment, and collaboration between wind energy decision makers and stakeholders. Feedback from the stakeholders also led to additional requirements and insight on how the design of the prototype needs to be modified to increase its usefulness and ease of use. Further, the findings provided relevant information on social considerations and potential barriers that can influence the acceptance and use of AB-WINDEC in real-world conditions.

1. Introduction

The development of wind farms has significantly increased during the last 20 years in Canada. Given that a typical wind farm can contain several hundred wind turbines and cover hundreds of square miles (Leung and Yang, 2012), their planning and building frequently presents a critical challenge for land use planning. One such problem, and often one of the most difficult to resolve, is the selection of locations where these wind farms can be built (Ramírez-Rosado et al., 2008).

In Alberta, there is currently much debate about the potential impacts of wind farms on other land uses (Alberta, 2008; Armstrong et al., 2005; Cheryl and Marilyn, 2010; Ingelson and Kalt, 2010; Johnson et al., 2011; Macarthur, 2010; Weis et al., 2010). At the heart of this land use planning problem is the need to protect public interests and to weigh these interests against the rights and interests of individuals and private organizations who are proponents of wind farm development (Chernoff, 2015; Coles and Taylor, 1993; Fabos, 1985). As public concern about the impact of wind farms has grown, conflicts between public and private interests are also on the rise. One reason for this is that public planning decisions regarding wind farm placement locations tend to involve multiple stakeholders, including planners, regulatory officials, industry developers, conservationists, municipal officials, public interests groups, and land owners (Thibault et al., 2013). In a broad sense, stakeholders can be described as individuals or groups that have an interest or concern in an issue. These stakeholders come to the debate with different preferences, different values, and knowledge. Moreover, their decision making is often influenced by different social, economic, and political factors (Cathcart, 2011). In addition to being spatially-explicit, a feature that most wind farm placement planning processes have in common is that they have multi-criteria issues that require consideration (Talinli et al., 2011). These scenarios, and the range of social issues and their inter-relationships, call for a more focused decision making, and highlights the need to improve ways of analyzing complex information (Dye and Shaw, 2007; Kiker et al., 2005), in order to make decisions that would be fair to all parties (Khan, 2003).

Clearly, both the results of the decision-making process and the technologies that facilitate the process are important considerations in the Alberta context. Peer-reviewed research has generally supported

* Corresponding author at: Faculty of Environmental Design, University of Calgary, 2500 University Drive, Calgary, Canada.
E-mail address: osadagha@ucalgary.ca (O. Adagha).

http://dx.doi.org/10.1016/j.techfore.2017.01.007

the view that decision support tools are one of the promising solutions that can aid multiple stakeholders in understanding complex information when assessing potential placement locations (McKeown et al., 2011; Moiloa, 2009; Ramírez-Rosado et al., 2008). Part of the attraction to such tools, according to Moss et al. (2014), is their ability to harness place-specific data, facilitate data storage, analysis, and visualization. Harnessing the power and potential of decision support tools could help focus attention on the real issues that inform the decisions on placement locations for wind farms (Cathcart, 2011), and could thus enhance capacity for evaluating placement alternatives (Wang, 2015).

With the foregoing, there is little doubt that the complexity of decision support problems like wind farm placement planning requires the development and application of new tools capable of incorporating not only numerical data, but also qualitative information used by stakeholders involved in the decision-making processes (Poch et al., 2004). This problem presents a difficult challenge for systems designers (Carlsson et al., 2011; Perini and Susi, 2004). Dozier and Gail (2009) opined that effective decision support tools could lead to more satisfactory decision-making processes and outcomes if their development processes are guided by empirical research. Other authors have argued that the understanding of how decision support tools can be developed and successfully integrated into decision processes is critically important in increasing their acceptance (Kushniruk and Patel, 2004; Maguire, 2001). Many poorly designed systems tools exist because often the perspectives of the people who use the systems were not integrated in the development process (Lu and Cai, 2000).

With the increasing involvement of stakeholders in wind farm planning processes, it is expected that decision-making would become more interactive and complex, demanding interactive and visual-based tools to manage it. Accordingly, a recent design study by researchers at the University of Calgary empirically examined ways in which a visual analytics decision support tool can be developed to address the issues stated above (Adagha et al., 2015a, 2015b). In their work, a socio-technical approach was used to identify the decision support requirements of wind energy stakeholders in Alberta and to develop a conceptual framework in response to the requirements. Their study also determined the underlying attributes of effective visual analytics decision support tools, and how those attributes can be applied to design a tool to match the socio-technical requirements of stakeholders involved in wind farm placement planning in Alberta. Based on the established requirements, attributes, and conceptual framework, a proof-of-concept, web-based Alberta Wind decision support prototype tool (AB–WINDEC) was developed. The concept of AB–WINDEC is based on integrating different interests and views of multiple stakeholders. The systems model is designed to facilitate interactive visualization and analytics, situation awareness, creativity, and collaboration, and to support different phases of the decision process.

This article continues the design series from a formative evaluation standpoint. Evaluation is a crucial component in the design of decision support tools (Hevner et al., 2004). The primary measure of success of a tool is the degree to which it meets the purpose for which it was intended. Such evaluation should elicit feedback on a tool's usability and perceived usefulness, which is crucial to increasing the acceptance and integration of tools in real-world settings. While the idea of designing tools, identifying and monitoring measures of success, and using the resulting information to improve planning tools might appear to be a straightforward process, a myriad of social, technological, and methodological issues makes this a very challenging undertaking. Critical perspectives in research have pinpointed key challenges in doing useful evaluations of decision support tools. Sojda (2007) contends that decision support tools designed to handle complex and poorly structured problems are often not empirically evaluated. Similarly, Newman et al. (2000) noted the implications of focusing an evaluation on intended use and intended users. In the view of Mysiak et al. (2005), what is generally lacking is a consensus about what evaluation methodology to use or what features to assess in the evaluation of decision support tools. Sprague and Carlson (1982) argue that evaluation of a decision support system should be treated as a research activity, which should focus on “value analysis”. A number of case studies (e.g. O'hEocha et al., 2012), have suggested that information systems designers would benefit from the inclusion of design evaluation research methods.

AB–WINDEC was designed with careful consideration of how the design process will affect its use in real world settings. From this context, a formal evaluation strategy should highlight the utility of helping intended users screen the most appropriate content, model, methods, and uses for their specific decision support needs (Parker et al., 2015). Such an approach would likely provide useful feedback that can help improve the quality of the product and the reliability of the design process (Hevner et al., 2004).

There are many ways in which this knowledge can be elicited in evaluation studies. These include questionnaire surveys, usability inspections, cognitive walkthroughs and observation of stakeholders operating the prototype in real-life situations. More recently, though, there has been a growing trend of using focus group methodologies to support these more conventional methods (Langford and McDonagh, 2003). This is largely due to the interactive and synergetic nature of group discussions, which allows deeper insights, and can facilitate more useful feedback on product design, in ways that may not be possible with other methods (Krueger and Casey, 2001). Furthermore, feedback from focus groups may have a greater chance of identifying new concepts that can be used to refine the design of a prototype system (Anastassova et al., 2007; Nunamaker and Chen, 1990). Thus, an empirical design evaluation can be used to address a wide range of important questions: What is the overall experience of using the prototype? What are the useful and not-so-useful features in the prototype? What are the usability challenges encountered on using the interface? What additional features are needed to improve ease-of-use? In what ways did the prototype meet stakeholder's needs, and what changes would improve its decision support capabilities? Are there any tasks not currently supported by the prototype? What other applications should be considered when re-designing the prototype? What are the barriers to use and integration?

In this study, answers to these questions are rigorously pursued through a series of focus groups with stakeholders in the Alberta wind energy sector. The article first describes the background research and contextual factors that gave birth to AB-WINDEC. It then reports on the methods used in conducting the focus groups. The article concludes with a discussion of the findings, study limitations, and contributions.

2. Research context

2.1. Development of the AB–WINDEC decision support tool

Can decision support tools be designed to meet the specific information needs and requirements of stakeholders? This concept was demonstrated in the Alberta Wind Decision support system (AB–WINDEC) – a prototype decision support tool that incorporates different social requirements, analytical models, visualization capabilities and other technical functionalities, to help stakeholders gather, structure, and analyze data when assessing placement locations for wind farms in Alberta (Adagha et al., 2015a). As the name implies, the AB–WINDEC is place-and-context specific. Although the term ‘place-specific’ is not well-defined as a resource management and decision support concept, it has been turning up in a number of academic discussions in planning theory and practice, for example, (Bagstad et al., 2013; Carrus, 2005; Cresswell, 2009; Creutzig et al., 2013; Friedmann, 2010; Nordström et al., 2011). As a geographic term, place-specific refers to a sense of place that has meaning and value to people (Williams and Stewart, 1998). Place-specific can also be defined as a social construct formed around shared identity, and information affecting the specific features or the distinctiveness of a given territory (Carrus, 2005).