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Review

Towards satisfying practitioners in using Planning Support Systems

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ABSTRACT

Several Planning Support Systems (PSS) have been developed so far, but their uptake in planning practice remains low. The analysis of the literature shows that one major factors for the limited use of PSS is the mismatch between PSS functionality (as well as the way it is provided through the PSS user interface) and what planners expect. This motivated a deeper research with the objective to analyse the factors preventing a wider use of PSS. In particular, this paper focuses on the usability of PSS. It reports an evaluation study performed to investigate the usability of PSS for some specific tasks: planners were involved in testing the land suitability analysis module of three PSS. The study results confirmed the mismatch between what PSS provide and what planners expect, as well as indicated a poor usability of PSS. Indications for improving the design of PSS that satisfy needs and desires of practitioners are provided.

Contents

1. Introduction and motivation

Planning professionals are faced with complex tasks as they require analysing vast arrays of disparate data for making decisions that endeavour to address the aspirations of cities wishing to be competitive,

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sustainable and resilient. In order to assist planners in the built environment, who are tasked with shaping the urban fabric of our cities, Planning Support Systems (PSS) have been developed as a decision support tool to assist data-driven land use planning. In this article, PSS are referred to as software tools that use simple or complex mathematical models for analysing and forecasting development of urban or regional land use. Over the last few decades, many PSS have been developed (see the PSS reported at: http://docs.aurin.org.au/projects/planning-support-systems/, accessed on July 10, 2017). Some are commercial products, e.g. Land Change Modeler (http://www.clarklabs.org), CommunityViz (Walker & Daniels, 2011), some are available as open software, e.g. UrbanSim (Waddell, 2002), CLUMondo (Asselen & Verburg, 2013), Online What if? (Pettit et al., 2015). PSS differ according to several features, for example, the tasks they address (e.g. to assess the impact of land use change, to allocate land uses for more sustainable development), the capabilities they possess (e.g. spatial analysis, map visualisation) and their implementation (e.g. standalone software, module within Geographic Information Systems (GIS), web application) (Pullar & McDonald, 1999).

Despite the proliferation of PSS, past research showed that the adoption and use of PSS by planners is limited. A debate on factors that hamper a wide use of PSS in practice has been going on among researchers for several years (see e.g., (Geertman, 2017, Vonk & Geertman, 2008, Vonk, Geertman, & Schot, 2005)). Low usability of PSS has been indicated as one of the relevant factors for this (Brömmelstroet, 2010; Vonk et al., 2005).

The research presented in this paper aims at providing a contribution to a debate about PSS adoption by investigating primarily on usability of PSS. Indeed, usability is the system quality factor that most affects people that use the system; it is characterised by several sub-attributes, as it will be illustrated in details later in this paper. This paper reports an evaluation study that was performed to analyse the usability of PSS and to better understand practitioners' expectations. The main goal of this study is to get PSS that can be used with satisfaction in planning practice, thus increasing PSS adoption. More specifically, this study provides a significant contribution by systematically highlighting the issue of PSS usability as emerged in a rigorous evaluation study. Indeed, it focuses on a common planning task as performed using three recognised PSS. This work builds upon previous research into the usability of PSS as provided by (Brömmelstroet, 2016; Papa, Silva, Brömmelstroet, & Hull, 2016) and reinforce the general finding that there still remain issues of PSS usability which underpin their adoption in planning practice.

The evaluation study involved six professional planners as participants of a user test. They were asked to perform a Land Suitability Analysis (LSA) with three PSS. LSA is one of the common activities undertaken by land use planners when performing site selection or strategic planning tasks, as illustrated by the considerable amount of literature on it and the various reported case studies (e.g. Jankowski & Richard, 1994; Klosterman, 1999; Pettit & Pullar, 1999; Pullar & McDonald, 1999). LSA determines the suitability of each land unit for a specific purpose, based on a set of parameters that the planners or actors in the planning process have to set in order to calculate the output. The user test had two main goals: 1) analysing possible usability problems that participants experienced; 2) better understanding planners' mental models and expectations in their interaction with PSS, in order to identify functionality desired by planners and, thus, provide PSS developers with insights for creating systems that satisfy practitioners by properly supporting their activities. Thus, the results of our work strive to improve PSS adoption in planning practice and offer valuable insights from planning practitioners. Most previous studies focus on the usability of PSS in the context of academic exercises (Pettit et al., 2013; Sharma, Pettit, Bishop, Chan, & Sheth, 2011; Waddell, 2002).

The structure of this paper is the following. Section 2 discusses related work. The key characteristics of the three PSS evaluated in the user study are described in Section 3. The overall study is reported in Section 4. Section 5 discusses the study findings in relation to indications for designing PSS capable of satisfying planning professionals. Section 6 provides conclusions.

2. Related work

A significant body of literature presenting and discussing PSS applications in specific contexts has been published (e.g. Stillwell, Geertman, & Openshaw, 1999; Brail & Klosterman, 2001; Hopkins, Ramanathan, & Pallathucheril, 2004; Brail, 2008; Geertman & Stillwell, 2009; Van der Hoeven, Van der Aarts, Van der Klis, & Koomen, 2009; Sharma et al., 2011; Geertman, Ferreira, Goodspeed, & Stillwell, 2015).

Although PSS have been available for more than two decades, their adoption by planners is rather low. Indeed, it has been shown that instrumental, human, organisational and institutional factors, such as low instrument quality, low awareness by planners and low diffusion to and within planning organisations, hamper the adoption of PSS (Brömmelstroet, 2013; Klosterman & Pettit, 2005; Russo, Lanzilotti, Costabile, & Pettit, 2017; Vonk & Geertman, 2008; Williamson & McFarland, 2012). Geertman (2017) recently analysed PSS from four perspectives, namely PSS history, PSS research, PSS education and PSS in practice, and encouraged to differentiate research on PSS in order to improve the body of knowledge and possibly PSS adoption in practice. In line with this suggestion of focusing on specific topics, our research analyses PSS usability, since low usability of PSS has been referred in the literature as one of the most important factors limiting PSS use by practitioners (Brömmelstroet, 2010; Vonk et al., 2005). Moreover, various experts in the field argue that in-depth research on PSS usability is required and that evaluation and improvement of PSS usability should be given a priority (Couclelis, 2005; Pelizaro, Arentze, & Timmermans, 2009; Williamson, 2012).

Usability is the most important software quality factor from the point of view of people who use a software system of any type (Nielsen, 1993; Rogers, Sharp, & Preece, 2013). In his seminal book on usability, Nielsen proposed a model in which he analysed the *acceptability* of an interactive system by users (Nielsen, 1993). The attributes of system acceptability, beside cost, reliability, compatibility with existing systems, etc., include *usefulness*, an attribute that indicates whether the system allows people to achieve their desired goals easily and with satisfaction. In Nielsen's model, usefulness is actually considered along two sub-dimensions: *utility* and *usability*. The former refers to whether the functionality provided by the system can do what is needed by users, while the latter refers to how well users can use the provided functionality. Specifically, usability is a multi-dimensional quality factor of a system, which can be decomposed in 5 sub-attributes: *learnability*, i.e., the ease of learning the functionality and the behaviour of the system; *efficiency*, i.e., the level of attainable productivity, once the user has learned the system; *memorability*, i.e., the ease of remembering the system functionality, after a period that the user has not interacted with it; *low error rate*, i.e., the capability of the system to support users in making less errors during the use of the system, and in case they make errors, the ease with which the user can recover from the errors; and *user's satisfaction*, i.e., the measure of how much the users like the system.

Usability is a well-defined concept within the Human-Computer Interaction (HCI) community, which has devoted extensive research to methodologies for designing usable systems and to methods for evaluating system usability. Instead, our analysis of the PSS literature revealed that there is still confusion about terms like usability, usefulness, utility of an interactive system. Today, the most accepted definition of usability by the HCI community is the one provided by the International Organization for Standardization (ISO) [ISO 9241-11, 2010], which decomposes usability along three dimensions: *efficiency* and *effectiveness* of the human-system interaction as well as *satisfaction* of people interacting with the system. In our research, we focus on usability as reported in the previous definition. In other words, rather than analysing which functionality is provided by the PSS, we are interested in analysing how well practitioners can use this functionality.