Environmental Science and Policy 89 (2018) 153–162

Contents lists available at ScienceDirect

Environmental Science and Policy

journal homepage: www.elsevier.com/locate/envsci

# Building effective Planning Support Systems for green urban water infrastructure—Practitioners' perceptions

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ARTICLE INFO

*Keywords:*
Water sensitive urban design
Low impact development
Planning Support Systems
Urban planning
Implementation gap
Strategic planning

ABSTRACT

The multiple benefits of adopting distributed, green stormwater technologies in the local environment are increasingly recognised, particularly in relation to water quality, flood mitigation, amenity and aesthetics. To advance the integration of these systems into everyday decision-making practices, Planning Support Systems (PSS) are considered vital. Despite several PSS available to support planners and key decision-makers, their uptake remains constrained; a phenomenon known as the 'implementation gap'. While scholars have hypothesised why the adoption of PSS is limited, there remains little empirical investigation regarding the reasons why. This paper tests the hypotheses underlying the implementation gap in relation to water sensitive urban design (WSUD) planning. Drawing on the tacit experience of 24 key urban water planning professionals in the front-runner city of Melbourne, Australia, in-depth semi-structured interviews were undertaken to unpack the contemporary planning processes used and reveal characteristics leading to success and failure of PSS application. Data analysis revealed WSUD planning professionals regard the adoption of PSS as a significant step towards improving contemporary decision-making practices, which are regarded as opportunistic rather than strategic. PSS use was widespread, though the type, intensity and sophistication of use varied among interview participants. Confirming the hypotheses from planning literature, practitioners suggested PSS need to be user-friendly and align closely to planning practice. Additionally, however, it was found that it is crucial for PSS to meet industry conventions. Suggested improvements to current PSS included incorporating socio-economic factors alongside biophysical and planning factors, hence the role for GIS-based suitability analysis tools. Overall, this study provides current and future PSS-developers with critical insights regarding the type, function and characteristics of an 'ideal' PSS aimed at enhancing the usefulness and uptake of PSS, and thus improve planning that supports expediting green infrastructure implementation.

## 1. Introduction

### 1.1. Background

Cities around the world are confronted with the negative impacts of increasing urbanisation and climate change. Impervious surfaces and changing weather patterns cause urban waterway degradation and increase flooding risks (Gill et al., 2007). Responding to this situation, Water Sensitive Urban Design (WSUD) in Australia, and similar concepts such as Low Impact Development (LID) in the US, Sustainable Urban Drainage Systems (SUDS) in the UK and Sponge Cities in China, have gained attention over the past decades as an adaptation and mitigation strategy that increases the liveability and resilience of cities (Fletcher et al., 2014). At the core of this strategy are distributed 'green' drainage infrastructures, such as raingardens and constructed wetlands. The application of varied multi-functional green infrastructures is aimed at protecting water quality, mitigating flood risks and providing additional benefits, such as improved amenity values, micro-climate and ecological habitat (Wong and Brown, 2009). Globally, the number of WSUD systems being adopted is growing. To ensure that technologies perform to their full capacity and deliver the full suite of benefits, due attention to their context is required to achieve successful integration into the urban landscape (Kuller et al., 2017).

WSUD departs from large scale, centralised single-objective urban

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https://doi.org/10.1016/j.envsci.2018.06.011
Received 18 May 2018; Received in revised form 12 June 2018; Accepted 12 June 2018

drainage systems that are predominantly hidden from the public eye. However, the multi-functionality of WSUD technologies widen the policy and decision-making contexts, for well-designed and well-situated WSUD assets can go beyond just urban drainage, to incorporate biodiversity targets, improved aesthetics and amenity and potential micro-climate benefits, among others (Fletcher et al., 2014; Sharma et al., 2016). With this in mind, strategic planning practices are required to incorporate all aspects of the urban context for WSUD integration: biophysical, socio-economic and urban form (Kuller et al., 2017). The multitude of relevant aspects and considerations make WSUD planning a complex task that calls for vertical (between different levels of government) and horizontal (among municipalities) alignment and integration of key policy and decision-making contexts. Indeed, Morison et al. (2010) highlight the importance of high levels of internal (between departments within an organisation) and external (between organisations) collaboration required to accomplish this integration (Morison et al., 2010). Currently, vertical misalignment of high-level policy is exacerbated by differences between municipalities in their levels of capacity and commitment to WSUD planning (Morison and Brown, 2011).

Effective planning for integrating WSUD technologies into the landscape requires an understanding of the varying functionalities associated with different WSUD approaches, a high-level of planning expertise and readily available data. Yet, current WSUD scholarship continues to highlight how the internal capacity of municipalities, where the majority of detailed WSUD planning is undertaken, is constrained by factors such as insufficient technical skills, high levels of staff turnover and lack of dedicated resources, among others (e.g. Brown et al., 2009a; Morison and Brown, 2011). To overcome these internal challenges, external expertise from engineering consultancies is typically sought. This has led to ad-hoc and opportunistic planning practices, which may result in long-term, sub-optimal outcomes (Kuller et al., 2018). Indeed, as Malekpour et al. (2015) highlight, reactive and incremental approaches to planning are ill-suited to guide a transition towards widespread adoption of WSUD approaches.

### 1.2. WSUD: urban planning and Planning Support Systems

Planning Support Systems (PSS) may be well suited to aid urban planning practitioners (Klosterman, 1997) and may help to overcome the challenges associated with collaboration and alignment of goals and interests in the water sector (Crona and Parker, 2012; Gibson et al., 2017). A myriad of PSS is available to planning practitioners (Kuller et al., 2017), including several recent PSS focussed on supporting WSUD implementation, such as UrbanBEATS (Bach, 2014), SUDSLOC (Ellis and Viavattene, 2014) and more (refer to Fig. 1) (Brown et al., 2009b; eWater, 2011; Fronteira et al., 2014; Makropoulos et al., 2008; Montalto et al., 2013; Morales-Torres et al., 2016; Rossman, 2010; Sitzenfrei et al., 2013; van de Ven et al., 2016).

The application of PSS is widely promoted in academic scholarship (e.g. Geertman and Stillwell, 2012; Klosterman, 1997; te Brömmelstroet, 2013) based on the recognised value of PSS in dealing with the growing complexities of urban planning tasks (Geertman, 2016; Poch et al., 2004). Nevertheless, the reported level of PSS uptake among planning professionals remains low (e.g. Gibson et al., 2017; te Brömmelstroet, 2013; Uran and Janssen, 2003; Vonk et al., 2005). The causes of this 'implementation gap' have been widely hypothesised over the past two decades. Although still the subject of academic debate, there is a growing consensus the implementation gap is the result of: limited exposure to and experience with PSS, a lack of data availability and quality, low user friendliness, and the simplicity and limited usefulness of outputs (te Brömmelstroet, 2013; Vonk et al., 2005). Despite these insights, there remains a lack of empirical research focussing on practitioner perceptions regarding the causes of this WSUD planning the implementation gap (McIntosh et al., 2007).

Contemporary PSS scholars point to a lack of direct engagement between PSS developers and everyday planning practices and practitioners, as the core of the implementation gap (e.g. Crona and Parker, 2012; McIntosh et al., 2007; Pelzer et al., 2015; Rodela et al., 2017; te Brömmelstroet, 2013; Vonk et al., 2005). Indeed, the failure to directly engage with PSS end-users has led to a range of weaknesses in PSS design, which ultimately act as barriers to uptake, which are summarised in Table 1. Reflecting the temporal challenge in relation to advancing PSS uptake, Table 1 reveals how similar challenges to those identified by Lee (1973) almost half a century ago are still relevant. Lee's (1973, p. 164), "seven sins of large scale models" p. 164: Lee (1973) closely mirror the contemporary barriers, including, among others: "hyper-comprehensiveness" (the drive to include too much detail in models), "hungriness" (the need for data inputs), "complicatedness" (high number of variables and relationships) and "mechanicalness" (deterministic, inflexible, inhumane thinking process of computers). Geertman (2016) concedes that many of these challenges are present today, though does acknowledge they vary depending on the domain of planning.

### 1.3. Aims and objectives

To advance WSUD implementation and avoid opportunistic implementation, this paper characterises practitioner's perceptions regarding the underlying issues associated with PSS adoption within the Australian urban context of metropolitan Melbourne. Drawing on the tacit experiences of contemporary planning practitioners engaged in WSUD practices, this qualitative research seeks to: (i) identify the perceived strengths and weaknesses of current WSUD planning processes, (ii) assess the current level and scope of PSS uptake and how this could be improved into the future to expedite WSUD implementation and (iii) compare the barriers to PSS uptake from literature with those found for WSUD planning. For the first time, the implementation gap is empirically tested for WSUD planning. It is one of the few attempts, to date, to empirically test the hypotheses for the PSS implementation gap in urban planning in general. Many important causes hypothesised to underlie the implementation gap were confirmed by our findings, such as user friendliness and relevance to the planning process. However, some other issues were found that were not before described to play a role in PSS uptake, most notably whether a PSS is industry convention. This research is undertaken in the context of the development of a novel planning support tool and will inform its design. In addition, it is anticipated that this research will provide PSS developers with critical insights regarding success factors for PSS uptake, enabling them to develop more successful models and tools to further urban planning practices.

## 2. Research approach

To explore how PSS can improve WSUD planning, two overarching research questions were formulated: (1) How are the characteristics of current WSUD planning practices and their outcomes perceived by planning practitioners? (2) What is the current and potential role that PSS can play to improve WSUD planning and (3) how can we improve the suitability of PSS towards this strategic planning for WSUD? While the answers to questions 1 and 2 are captured in the interview data, the discussion posits key design feature that might be necessary to improve PSS for WSUD planning (question 3). This qualitative research adopts a single case study design Creswell (2012) across multiple scales. Melbourne (Australia) was selected as our case study location. Melbourne has been on the journey towards WSUD for over a decade (CSIRO, 1999), gaining experience with WSUD implementation on the ground (e.g. Melbourne Water, 2005) as well as in policy throughout all levels of government (Brown et al., 2013). A strategic commitment towards WSUD is expressed from state (DELWP, 2016a,b), as well as local levels of government (e.g. City of Melbourne, 2017; City of Whittlesea, 2012), shaping an enabling context for ongoing WSUD development. We