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Understanding attitudes toward adoption of green infrastructure: A case study of US municipal officials

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ABSTRACT

The objective of this paper is to develop and test a theoretical model grounded in technology acceptance, diffusion of innovation and organizational theories to identify factors that influence attitudes of local jurisdiction officials toward adoption of green infrastructure for stormwater management. The hypotheses are tested using survey data on green infrastructure collected from 256 local governments' engineers, planners and other municipal officials across the US. Findings of structural equation modeling analyses partially support a hypothesis regarding the link between innovation characteristics and attitudes toward adoption, revealing that perceived usefulness has a significant direct influence on attitudes. They also confirm significant indirect effects of perceived compatibility, perceived internal readiness and perceived ease of use of green infrastructure on respondents' attitudes toward adoption. The contributions of this paper are two-fold. First, this study assesses the applicability of a model combining elements of technology acceptance, diffusion of innovation and organizational theory to predict municipal officials' attitudes toward green infrastructure. Second, it uncovers relevant innovation attributes explaining attitudes toward green stormwater infrastructure adoption.

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1. Introduction

Green infrastructure has been the subject of lengthy discussion and action in the US and moved closer to the center of both public and intellectual discourse on stormwater management and sustainability (Benedict and McMahon, 2006; Randolph, 2011). The engineering and ecological concepts underpinning green infrastructure systems are not entirely new as the base principles have arisen over time from multiple disciplines (Mell, 2008; Wright, 2011; Benedict and McMahon, 2006). However, green infrastructure in practice has appeared

as part of a novel, environmentally sensitive approach to stormwater management that uses small-scale, natural or engineered technologies and strategies to infiltrate and recycle stormwater runoff. It entails rain gardens, porous pavements, constructed wetlands, rain barrels, and many combinations of these techniques (USEPA, 2000; Clar, 2001; USEPA, 2010). Other practices include preserving environmentally sensitive site features such as riparian buffers, wetlands, valuable (mature) trees, flood plains, woodlands and areas with highly permeable soils (USEPA, 2000, 2007).

Mixed strategies involving both traditional systems and green infrastructure represent innovative and promising

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approaches to stormwater management at the local level (Jaffe et al., 2010). Several communities nationwide and abroad have sought to integrate green infrastructure into their control plans for stormwater runoff and combined sewer overflows, and many more are or will consider similar strategic investment choices soon (Wise et al., 2010). The city of Chicago, for example, is promoting the use of landscape-based green infrastructure practices to infiltrate and harvest rainwater before it enters the combined sewer and stormwater system. The portfolio of initiatives aimed at making the city greener and more sustainable includes green roofs incentives, tree canopy expansion and use of permeable paving materials in parking lanes and public alleys (USEPA, 2010). In Malmö, Sweden, the neighborhood of Augustenborg underwent a regeneration process that included retrofitting the existing drainage systems with retention ponds, ditches, green roofs and green spaces. The project has resulted in a 50% reduction in stormwater runoff rates, and the increase in green space has improved the overall image of the area (Kazmierczak and Carter, 2010).

Planners and others practitioners are increasingly drawing upon the concepts of green infrastructure and its value for managing stormwater runoff while promoting better urban landscapes, land conservation, and urban regeneration. Due to many barriers and impediments within the complex nature of stormwater management, however, the transition from traditional runoff control practices to system integrating green infrastructure design requires action on many fronts, including in the social, economic, and political-legislative spheres. Yet, little if any scholarly work has investigated the adoption of green stormwater infrastructure strategies in municipalities across the US or the attitudes of local planners, engineers, and other local government staff members involved in making decisions about stormwater management. This paper addresses this gap in the scholarly and green infrastructure literature by analyzing data from a nationwide survey of municipal staff members.

My study framework combines elements of the theory of technology acceptance (Davis, 1989) with aspects of diffusion of innovation theory (Rogers, 2003) and organizational theory (Vasi, 2006; Rogers, 2003; Damanpour, 1991) in a complementary manner to investigate how engineers, planners and other professionals working in US local governments perceive key attributes of green infrastructure. To the best of my knowledge, this paper is the first study to test the applicability of elements of these theoretical frameworks to predict municipal officials' attitudes toward adoption of green stormwater infrastructure. Attitudes toward an innovation can facilitate or limit the adoption and implementation of new technologies (Damanpour, 1991; Frambach and Schillewaert, 2002). In fact, attitudes can be a precursor to the decision of whether to try a new practice and influence decision processes regarding innovation (Frambach and Schillewaert, 2002; Rogers, 2003). While stormwater managers and other officials lack the authority to unilaterally adopt and implement green infrastructure, they do have the ability to educate citizens and political leaders about the value of green infrastructure in mitigating issues relating to urban stormwater runoff and thus could become change catalysts (Kahan et al., 2011). Thus, a deeper understanding of factors affecting local government

officials' attitudes toward adoption of an innovation is important in for assessing how best to disseminate and implement these technologies. Ultimately, the answers to these questions can help us understand some elements of the processes and factors that drive environmental innovation adoption by local governments.

The rest of the paper is structured as follows. I first develop direct and moderating hypotheses for the relationship between green infrastructure, the characteristics of officials and their jurisdictions, and attitudes toward adoption. Then, I test the hypotheses by analyzing the data obtained from a nationwide survey of engineers, planners, and other officials in local jurisdictions across the US. At the end, I present the analysis results and discuss implications for policymaking and diffusion of green infrastructure.

2. Background

Despite the increasing interest in green infrastructure, most local entities face a number of social, institutional and procedural obstacles that limit adoption, and some policy interventions to promote green infrastructure remain unrealized (Brown, 2005; Brown and Farrelly, 2009; Abhold et al., 2011). Recent studies on green infrastructure identify negative attitude toward adoption and resistance to change as common barrier inhibiting the transition to this sustainable stormwater management system (Abhold et al., 2011; Funkhouser, 2007). As local government staff members may prefer to use well-established engineering practices and rely on systems that have been tested rather than risk trying new alternatives (Abhold et al., 2011; Coffman, 2002; Godwin et al., 2008), it is important to understand factors affecting their attitudes toward adoption to best support dissemination of these practices. Perceived limited financial resources and lack of skilled and knowledgeable staff members, perceived complexity of design and technical components, and poor understanding of the benefits associated with implementation are some of the potential sources of resistance and negative attitudes toward green infrastructure. Yet, while stormwater managers and other officials lack the authority to unilaterally adopt and implement green infrastructure, they do have the ability to educate citizens and political leaders about the value of green infrastructure in mitigating issues relating to urban stormwater runoff. They thus could become change catalysts (Kahan et al., 2011).

Researchers have taken advantage of the Diffusion of Innovation (DOI) theory to understand whether an individual or organization will adopt one of many new products, processes or policies (e.g., Matisoff, 2008; Sharp et al., 2011; Zeldin et al., 2005). An innovation is an idea, practice or product that is perceived as new by the unit of adoption (Rogers, 2003; Faber, 2002). Within an organization, successful and continuous adoption of an innovation requires acceptance by the employees (Frambach and Schillewaert, 2002), who evaluate the new product and, based upon this evaluation, form a positive or negative attitude toward it (Rogers, 2003).

Among other factors, innovation adoption theory links the formation of a favorable or unfavorable attitude toward

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