**A Tool for Sustainable Residential Water Management in Architectural Design Delivery**

Water problems due to scarcity or climate change are becoming critical for survival nowadays. However, designing for sustainable water management (SWM) requires a change in the traditional process followed by design professionals [1]. The sustainable approach encourages the incorporation of water management requirements in early phases of design [2] where the design process acts as a key tool to find solutions in an innovative and coherent way [3]. It requires prompt information for decision-making for a variety of stakeholders [4], and a holistic approach [5]. However, research on SWM has been oriented to a specific design professionals or problems without integrating them. Thus, at present, research about designers' professional practices on SWM lacks collaborative decision-making and holistic approach. Furthermore, SWM is an emergent topic in building design, especially in the residential sector in the U.S., leading to unexplored problems, unproven solutions and, in some cases, to its rejection. Complexity in design, water balance calculation and current obstacles from regulations are some of the detractors of a comprehensive implementation of SWM. In the near future, due to the effects of climate change, water scarcity and/or increase in sustainability awareness, it is expected that demand for sustainable residential water management (SRWM) practices will increase. Even though, research, tools and guidelines have been developed for SWM, a lack of tools oriented to the architectural design (ADD) delivery is observed for 1) early design phases that support the selection of SWM strategies based on economic and environmental factors, 2) for site and residential buildings, 3) for addressing the collaborative [6], 4) for iterative and dynamic of designers' work, and 5) for integrating information across design phases over time [6-9]. This research aims to develop an online software tool that contains the above-mentioned characteristics, test it and make recommendations for further development.

The definition of tool's requirements that respond to needs and motivations of architects and stakeholders about SWM for the residential context have been performed by the means of a national survey, an ethnographic study, and literature review.

A national survey entitled "Sustainable Water Management in the Residential Sector: Assessing Tendencies and Adoption in Design" was administered to identify trends and needs in design practices, Best Management Practices (BMPs) implementation and tools in meeting SWM. The population target was architects, landscape architects and engineers with green design background. Results show that 1) professionals are familiar with concepts and practices of SWM from LEED, but not with more demanding and holistic approaches such as the Living Building Challenge (LBC) standard, 2) the most implemented BMPs were the simpler ones required by client or regulations, or Leadership in Energy and Environmental Design (LEED) credits. The least implemented BMPs were the more complex systems that present high costs, high client rejection, or challenges due to regulations, and 3) an application supporting SWM design should be interoperable, easy to use and adapted to different design phases.

Further, an ethnographic study on Architectural Design and decision-making process was implemented to unveil the decision making process about sustainable water management during the design of the Environmental Center Project of the Pittsburgh Parks Conservancy organization. This study collected information from interaction among designers in a natural setting facing the challenges of deciding and designing for the Water Petals objectives of LBC a the project in order to obtain a more complete idea of all elements involved in the process. Results show that 1) decision for SWM are made throughout all phases of the design process, 2) design process of SWM is iterative and dynamic throughout all phases of building life cycle, 3) new or more accurate information is searched as needed [6], and 4) postponement on decision-making are due to information not available, not confirmed, or influence of “willful choices”[10].

Based on the literature review and research projects performed, the development of a tool for the ADD process for sites/buildings involves the following areas of study:

1. Integration of water performance assessment of SWM in the ADD process. This area entails defining the resolution of information needed in each phase of ADD, adapting the data input to different levels of designer’s expertise about SWM and the dynamics of ADD process [6].
2. Incorporation and testing the new tool under architect-friendly criteria. Two guidelines will be use to test architect friendly criteria over the prototype: [7-9] Akin [7] and Ozkaya and Akin [8,9] work. Key factors that make tools to be tailored for architects are 1) “support easy understanding of system capabilities, transparency of system operations and ease of adaptation”[7, p11], 2) integration of knowledge-base into software for supporting decision making, and 3) interoperability among others.
3. Collaborative design and integration of water performance assessment of site and building into a more complete environmental analysis of building. This area entails how to facilitate the interaction between architects, clients and consultants in water assessment towards the understanding and use of environmental parameters during the design process [6].

Part of these requirements has been collected by the survey, ethnographic study and literature review work done so far. More details and definitions will be attained during the next phases of my research, the development and testing of the tool prototype. The envisioned tool is an online software that contains a user interface, a calculator engine and a database where all information and interactions among users will be managed in a external server. Individual and group user testing will be performed to validate that the tool complies with its purposes.

I expect that results from this research will be 1) a tool rooted on reality of architectural and sustainable residential water management practice, a tool that is aimed to be used to improve the integration of sustainability in the built environment; 2) a better understanding of early phases of architectural design process for SWM in specific for residential buildings. This will inform and recommend improvements for future development of tools and the practice in SRWM.

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