Designing for System Change: Innovation, Practice and Everyday Water

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Abstract

In this paper we examine the installation and trial of a novel system of integrated water management from the perspective of household users in order to reveal the importance of considering social practices in the adoption of innovative water management systems, and in the process reframe the ways in which the implementation of water conserving technologies is understood. Drawing on a case study in peri-urban Victoria, Australia, this paper analyses the experiences of 25 household residents over an 18-month period to determine how household users adapted their everyday water use (or not) to a new water management system. This research focuses on three important domains of practice in water management – toileting, cleaning and communication – to reveal the tension between established and novel practices. Our findings demonstrate that the conventional focus on technocratic and engineering-oriented components of system innovation by the

water sector may actually impede the successful implementation and use of innovative, potentially more sustainable, water and sanitation systems. This paper suggests what is needed is an approach to system innovation that takes daily discourses, community knowledge, practices and the localised contexts of water users as critical in influencing the successful uptake of small-scale innovative water systems.

Introduction

In this paper we investigate the implementation and use of novel systems of water and sewage management in a community scale trial to research the importance of social practices in the successful adoption of innovative small-scale water systems. In the trial, the sustainability potential of the novel sanitation system in part relied on the ability of residents to adopt new practices in both using and managing the system. The aim of the research project was therefore to explore the socio-material relationships associated with introducing these novel systems of water sanitation in practice. This paper critically analyses the social data emerging from the project, revealing the complex social dimensions of sociotechnical systems in a domestic community context. From the tacit, hybridised relationships people form with technologies over time to the everyday conversations where opinions and experiences are shared, this paper speculates on the critical role that such practices play in transitioning to more sustainable water and sewage management.

The trial involved a peri-urban Australian community of 25 households in which an integrated water management system was installed. Three important domains of practice – toileting, cleaning and communication – emerged as important conditioning influences on system innovation. In particular, the case study highlighted that locally embedded toilet and cleaning practices differed from expectations by the water utility. Lower than expected water use, irregular toilet flushing habits, male practices of outdoor urination, and in a majority of cases, a lack of acceptance of high-tech recycled water systems by participants in favour of rainwater tanks, emerged to hamper the effectiveness of the technological system water managers selected for the trial. In addition, voluntary participation in the trial was based on shared knowledge and experiences amongst participating neighbours. Therefore social learning amongst participants in the trial was revealed to be critical for the successful adoption of the system in practice.

Our findings demonstrate that existing understandings of system innovation which perpetuate the assumptions of a technocratic and engineering-oriented perspective of system change conventionally adopted by water sector by planners and policy makers, has the potential to impede success and in the process limit the sustainability potential of novel technological water systems. These findings suggest that a sociological perspective on system innovation that takes into consideration the daily discourses, everyday practices and local contexts of water users is critical when planning for system change. In addition, attending to the

social dynamics of learning amongst participants adopting innovation has the potential to help support the adoption process amongst community members and the diffusion of innovation more broadly in practice.

The following section outlines our critique of existing approaches to system innovation and introduces an alternative practice-based approach that places higher value on the social dimensions of socio-technical change than conventionally considered within the Australian water sector, particularly at the stages of planning and implementation where system change becomes much more a matter of everyday negotiations. We then outline the background and context of our case study before summarising some of our key findings, as they relate to our empirical focus on toileting, cleaning and communication. The final section concludes with a discussion about the value of considering social practices in the planning and implementation of system change.

Social Practices and System Innovation

The key point this paper makes is that the introduction of alternative innovative water systems of service provision may create significant tension for household residents attempting to negotiate the use of novel systems in practice, which raises questions about the ways in which novel systems are implemented by water utilities. Achieving a better understanding of how novel systems are used, managed and maintained within the microcosm of everyday household practice therefore becomes critically important in determining the viability of sustainable innovation. This implies that social network building with users of novel technological systems prior to the installation of the system is just as important, if not more important, than technological experimentation itself. Subsequently, researching how residents adapt to the use of novel water and wastewater systems requires nuanced research approaches (discussed in more detail in following sections).

A useful theoretical frame for researching household water practices comes from a body of literature known as social practice theory. While there is no comprehensive definition of practices in the literature, practices can be broadly defined as bundles of activities or an organised nexus of actions (Schatzki, 2002, 71) that occur in the social domain. Reckwitz (2002, 249-50) provides an often-cited definition of practice:

> A 'practice' is a routinized type of behaviour which consists of several elements, interconnected to one other: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge.

Building on Reckwitz's definition, the practice theory framework of Shove *et al*. (2012) suggests that practices depend upon the interconnection between three main elements that constitute: (1) things – that is, *materials*, (2) bodily knowledge

– that is a competence or *skill,* and (3) mental activities – that is symbolic meaning and *images*. Practices emerge, develop, stabilise and potentially die off as the links between these elements (materials, skills and images) are created, supported, maintained and broken (Shove *et al*., 2012).

In addition, Strengers (2010, 7) notes that practices "are seemingly inconsequential, inconspicuous and mundane but nonetheless essential to our day to day lives", which is an appropriate way to describe practices associated with everyday household water practices. The embedded, inconspicuous and habitual nature of practices means that the skill sets they require exist in practical rather than discursive consciousness (Giddens, 1984). The things of wastewater practices – toilet hardware, toilet paper, flush mechanisms, taps, shower heads, cleaning products, pipes, tanks and so on – do not have a stable identity within practices. Some of these things (tanks, pipes, integration points) have more the character of mental images rather than material things as they are out of sight. But any of these things could lose their inconspicuous quality if they break down or do not function in a familiar way. This observation relates to Heidegger's (2010) understanding of handlability by which we come to understand the world practically through our use of things, rather than theoretically. The breakdown, which entails the surfacing of material elements usually excluded from consciousness, is not necessarily negative; rather this interruption ushers in the possibility for learning and innovation in practice (Winograd and Flores, 1987; Willis, 2006). Kaika (2004) suggests that the breakdown also allows a confrontation between the household resident and his/her alienation from biophysical nature, reinforced by technologies such as flush toilets, which are designed to expedite the removal of waste as quickly as possible.

Practice theory enables a close analysis of the ways in which the meaning of water is socially and materially constructed, in this case, on the demand side of the water management equation. Sofoulis (2005) identifies a significant gap in research in regard to how and why people use water. Critically attending to social practices goes some way to bridge this gap by revealing domestic water users as on-site water managers involved in negotiating aspects of the system in relation to their existing water management practices. Findeli (2008) argues that design is a process of transforming facts into values via human engagement. Facts become values as technologies become socialised. By unpacking the practices of domestic water management the role of lived practice in system implementation is made discursively available. Enabling discursivity is critical in the scaling down practices explored in this special issue. In allied studies such as Sofoulis' (2005) investigation of the transfer of big water into everyday water, water diaries became minor tools of situated demand management for the everyday water users. Such applied research ekes out a space for the better articulation of insights from social research into urban water management practice (Sofoulis this issue).

This research paper argues for the importance of social network building in the context of introducing water conservation technologies, which is modelled by the social research performed. This network building could, we suggest, enable a

more transparent and dialogical relationship between water utilities and end-users and create capacity for the implementation of more sustainable systems to be a less instrumental, and more reflexive and open – that is, social process. Such an approach could, we suggest, lead to greater success in establishing more sustainable water systems.

Insight into how one might successfully introduce novel water technologies into the home from a practice-based perspective requires first understanding the complex cultural meanings and values influencing patterns of domestic water consumption. Small-scale water systems make good case studies for social and cultural research as their operation cannot be studied without examining how people interact and use these systems in everyday practice.

The value of investigating meaning, values and patterns of consumption prior to the development and installation of novel water technologies is not to predict and manipulate behaviour of household users, but rather to identify the multitude of factors influencing and reinforcing these patterns of use (Fam and Sofoulis, in press). A practice-based investigation of water use patterns has the potential to reveal how household users actually value and use these systems in practice in contrast to expected patterns of use conventionally adopted by water utilities when selecting appropriate technology for community projects (such as the one discussed in this paper). As an illustrative example, the suite of technologies (urine diversion toilets, grey water recycling systems and septic system) selected and installed by water planners for the trial discussed in this paper did not take into consideration already conservative water use habits, local demographics and preferences for rainwater sources by community participants. As a result the acceptability of grey water recycling technologies was low, with preference given to the use of rainwater tanks by many residents.

Of particular relevance in this case study are the historical meanings influencing water use patterns. As others have noted (Røpke, 2009; Moy & Fam, in press), the materials used to carry out the practice and the way the practice is performed (competence) is often passed down, taught or observed. For example, water users in drought prone areas dependent on rainwater harvesting have different historically derived water practices than urban city dwellers who need only to turn on a tap for an abundant water supply.

An important starting point for developing practical policies for small scale systems is to first acknowledge and embrace the heterogenous views, diverse practices and historical contexts people engage in and are influenced by in everyday water use. A practice-based approach to system design represents a paradigm shift for water planners, policymakers and technocrats, because they are unfamiliar with the notion of heterogeneity in water planning (Fam & Sofoulis, in press). Large-scale water systems have evolved in Australia as homogenous systems of supply regardless of how water is used at the community scale. The intimacy of small-scale systems, particularly on-site systems installed within

households, requires embracing heterogeneity and understanding how people/communities think, feel, act and interact with these systems in practice. In explaining why water is demanded and used in different ways by different people, Sofoulis (this issue) highlights the range of reinforcing factors in play, suggesting that it is the range of "historical, infrastructural, cultural, sociotechnical, political, capitalist, social justice, environmental, intergenerational and ethical" factors that need to be reflected upon particularly if novel systems, radically different from the mainstream, are expected to be adopted by users.

The potential role of small-scale systems to meet future urban sustainability goals is currently being explored by a number of water utilities and councils across Australia. In Sydney, for example, the local council has proposed a Decentralised Water Master Plan to meet 2030 sustainability targets of the city through small-scale decentralised systems (City of Sydney, 2012). The challenging questions posed by introducing such systems revolve around issues of governance, public health, and establishment of roles and responsibilities of water providers, the private and public sector and consumers (see Sofoulis, this issue). What a closer examination of social practices provides is a way of determining the most appropriate systems for specific (often complex) local contexts of use.

Background Context: The Story of the Trial

In 2008 a peri-urban Victorian community was targeted by a local water utility for a sewerage service extension program to trial a novel technological system that offered more sustainable outcomes. Residential properties in the trial required alternative water and sanitation systems due to poor performance of septic systems and proximity of residential dwellings to a National Park where stormwater and sewage runoff were negatively affecting waterways. The selected system incorporated urine diversion where urine is separated through a specifically designed urine diversion toilet, collected and reused for its nutrient content in agriculture – in this case a local turf farm. The system also included a recycled water and septic system. This was the first time the technologies had been installed as an integrated system in an experimental setting in Australia.

The trial aimed to determine the viability of the technologies installed to provide sustainable outcomes for the community with 40 households involved in the trial. In planning and implementing the project, the water utility recognised that the successful adoption of innovation would be a complex process implicating people and therefore took the unusual step of commissioning qualitative social research. The social research focused on capturing changing perceptions of household residents using the new systems, which were continuously fed back to the water utility through regular progress reporting.

We conducted what have been termed *ethnographies of situated practice* (Suchman, 1984; Hutchins, 1993; Orlikowski, 2002) in order to understand localised knowledge, meaning, materiality and action. We explored how the spatial

and temporal influence of established and emerging practices were constituted, evolved and changed over the time period of the research and the tension that emerged between new and old practices. Understanding how socio-cultural practices are implicated in adapting to novel technological systems was gained through a longitudinal study where residents voluntarily participated in semi-structured interviews, during the pre-installation and post installation phases of the trial.

The user group involved in this research was distinctive in that residents had never been connected to reticulated water or sewerage services. Household residents therefore relied on rainwater tanks for water supply and on-site septic systems to manage sewage with the vast majority of residents in the trial tending toward conserving water use practices. For outdoor uses such as gardening, residents commonly recycled household grey water, while toilets were flushed sparingly. Referring to their conservative practices in toilet flushing, a number of residents in the research recounted the motto, "if it's yellow let it mellow; if it's brown flush it down". These established, relatively conservative water use practices by residents were not taken into consideration in the design of the trial, and little was known about who was using water and why within households, or, importantly, how much water was used in comparison to city dwellers. The conservative disposition of local residents in handling water meant that certain aspects of the system, such as the high-tech recycled water system, were not as readily accepted by the community as expected. One resident reflected, "…I don't care that much [about the recycled water system] because I never had a problem with water, always had enough water…. pretty well self-sufficient that way". It is interesting to note that at the end of the trial a significant proportion of residents had dismantled the recycled water system in preference for rainwater tanks.

Everyday practices such as toileting, cleaning, and communicating emerged strongly in the research. The results unveiled the complexity of negotiating precedent and new knowledge and in the process adopting new practices. These results challenge the notion that innovation and system change can happen intuitively in the background of practices without emerging into discursive consciousness. This revelation disputes the view that innovation is a purely technological issue and highlights the implications for designing new technological systems and socio-technical experiments. The following section expands on these findings with illustrative examples of the tension associated with residents negotiating new practices.

Toileting, Cleaning and Communicating

What is rarely highlighted in the characterisation of stakeholders in socio-technical experiments is the importance of the end-user of innovation and the need for a change of practice in the process of adopting novel technological systems. Therefore the adoption of alternative technologies that require a divergence from conventional practices is not just about *buying and installing* these technologies but

importantly about integrating them into *practice,* in what Lie and Sorenson (1996) call the *domestication process*. The importance of user acceptance and adaptation to Urine Diverting Toilets (UDTs) in everyday practice has been identified by Fam and Mitchell (2013) in international case studies where a greater success rate was achieved when residents were actively involved in discussions about the development and organisation of the UD system and how it would be incorporated into daily living, than when they were not.

While there were a number of negotiated practices required by residents adopting the new system in the Victorian trial, the study revealed three key practices, *toileting, cleaning* and *communicating*, as touch points for understanding the tension between existing established practices and the need to change or adapt to new, more precarious practices. Precarity in this case is used to characterise those emerging practices that are unpracticed or not yet habituated, and therefore more susceptible to failure.

Toileting

Toilet practices are commonly a taboo subject and rarely discussed in polite company, therefore it was surprising that residents freely discussed toilet practices with the researcher, revealing the challenges of using the urine diversion toilets (UDTs) as a component of the integrated water systems being trialled. While both male and female residents discussed the challenges of using and adopting the UDTs, in particular it was male residents who faced the greatest challenges in adopting new practices.

A high proportion of male residents urinated outside either regularly or occasionally. In interviewing male residents on their perceptions of UDTs a recurring theme was that men would prefer to answer the call of nature *in* nature as it were. This outdoor toileting practice referred to by male residents was a practice established prior to the trial. As a means of reducing water consumption and limiting the nutrient load inherent in urine to septic systems, one male resident reflected, "I mean half the people here just use lemon trees, you know.…I mean beforehand [when] we had septics, most of the blokes wouldn't use the toilet, most of the time anyway, because…you're just overworking your septic system…. it's pointless flushing toilets…all the time".

The incentive for this practice was not only water conservation but also a desire to limit the impact of urine and therefore nutrient loads on the septic system. The relationship between the practice components of materials, skills and meaning around toileting, are clearly demonstrated in this example. The outdoor toileting practice was reinforced by the use of a septic tank, as a particular type of technology. The knowledge of optimal working conditions of the septic tank – that is, reducing nutrient loads to the system – legitimated the practice as a way of using existing knowledge in action. Although it may not be possible to urinate outdoors in a densely populated urban centre, the sparsely populated peri-urban community

involved in the trial supported and normalised this practice by male residents. In this sense, the introduction of the new system incorporating urine diversion toilets (UDTs) sat within an established practice, reinforced by the type of technology used (septic tanks), the contextual environment in which the practice occurred (the semi-rural community) and established knowledge of the septic tank.

In this sense, the UDT's represented a somewhat clumsy appropriation of an existing conservative practice. As one participant stated, "I don't know if it's just my bum or what it is. I just don't like - it makes it harder to go to the toilet really…You must be alright if you've got a small bum really; I don't know. I just can't use it*"* What is also at play here perhaps is the fact that participants were already reducing nutrient loads and redirecting their bodily resources for outdoor gardens in their existing practices.

Cleaning

As Shove (2003) has highlighted, cleaning is a complex task, one that has been significantly transformed over decades by the introduction of new devices, materials and appliances. The symbolic and moral significance of cleaning tends to be linked to conventions that determine what is right and proper (Wong and Brown, 2009) but also as a material expression of care for those in our charge (Gill and Mellick-Lopes, 2011). The difference between the UDT and the conventional flushing toilet is that it requires the user to position themselves differently on the toilet and use different cleaning products and tools such as biodegradable agents and toilet brushes. More time is required to clean the system due to the design of the bowl, which is shaped to collect urine rather than just flush water and wastewater away. For some residents the practice of cleaning was a daily ritual integral to the domestication of the new system, ensuring a particular standard of cleanliness was sustained. This created a strong impression of precedent meanings around cleanliness expressed through everyday practices. One particular resident noted that, "to me you just have the toilet that little bit cleaner than normal… every night… the Harpic [toilet cleaner] up the rim and the bowl cleaner around the bowl. Every night when we go to bed then you know the next morning it's clean".

The references to cleaning by residents arose not only with regard to cleaning toilets but also in relation to cleaning clothes where the perception of clean verses dirty water for clothes washing was challenged by the introduction of a high tech recycled water system. The recycled water system collecting water from the washing machine, showers and kitchen sinks, treated the water to Class A quality standards, before being plumbed back into the house for toilet flushing and clothes washing, as well as outdoor uses. There are different grades of recycled water from Class A to Class D. Class A is the highest quality and is used exclusively in residential areas where recycled water is supplied. Although adequate for washing clothes and flushing toilets, the use of recycled water was adamantly opposed by one resident due to the entrenched character of precedent

meanings attached to standards of cleanliness and limited acceptance of recycled water systems for indoor uses:

> …no they are not going to have my shower water going in (the water recycling system), I'm not going to have that. I don't care about it going in and using it for the toilets, doesn't worry me, but I don't want that going through my clothes and through my washing machine…. No, just the thought of it…I am real fussy with my clothes, everything of mine comes out sparkly.

Such comments illustrate both the idiosyncratic nature and resilience of existing social practices as well as how meanings around good and bad water (Kaika, 2004) become practically significant. This example suggests the need to offer adequate knowledge and know-how on recycled systems as a critical component of supporting new practices, as well as opportunities to experience the system in practice, and time to adapt personal standards to new systems. Knowledge and experiential learning have the potential to provide evidence for the standards and quality of recycled water, and are also a means of overcoming preconceptions that recycled water is dirty and unsuitable for non-potable indoor use. Although an information manual was prepared for residents to explain the recycled water system, a lack of experience in using and managing the system in everyday practice meant there were misconceptions, and recycled water was rejected as an alternative water source by some residents. Regardless of theoretical acceptability, the ways in which things are experienced in practice, matters.

Communicating

Although interviews aimed to capture individual perceptions of the technological system, social interaction, conversation and debate amongst neighbours themselves was an important part of negotiating the tension between old and new practices. As an illustration of the importance of conversation, the vast majority of residents involved in the trial could describe the social and technical challenges their neighbours faced in using their UDTs. One resident knew intimate details of how his neighbour used and cleaned his UDT: "He said they're not too good to clean out…he reckons he has to clean out the urine….every now and then with skewers!". Another noted the frequency of problems with a neighbour's system: "…apparently [the next door neighbour's] having a problem [with the UDTs]…they've been having a problem every week or fortnight…".

Although conversations on the failure of the system to function as expected was a common point of discussion between residents, positive experiences were also discussed. In some cases these resulted in the recruitment of other neighbours into the trial. According to one resident, "…I spoke to neighbours who had been here forever and they said, we're doing it, it sounds like a good thing. Yes [I thought] alright I'll do it."

After communication with neighbours and fellow residents involved in the trial, some residents made decisions to adopt the system and particular methods of cleaning and maintaining the system, suggesting an explicit need for knowledge sharing as part of the adoption process. In this way, there seemed to be anticipation of collective support by residents where they felt, 'I am not alone' in trialling these systems and negotiating new practices. Our research highlights the multiple levels of conversation around the subject of toilets. For instance, while western toileting culture might be taboo at the macro level of broad societal conversations, in everyday practice, intimate engagements have been identified in the research as lively domestic spaces for neighbourhood conversations on toileting.

From the evidence provided, it would seem important to delineate a supportive social context for the introduction of innovative systems that require the adoption of new, unfamiliar practices and management strategies. This example highlights that communication between residents became a way of developing know-how in relation to the system, an important component of an established practice.

Discussion

As Shove and Walker (2007, 2010) have noted, the emphasis on innovation in the transition literature has an implicit focus on technical systems and infrastructures of provision and supply, which often overlooks the importance of lived social practices. In this paper we have aimed to explore the socio-cultural considerations at play in the assimilation of new practices within a situated context and moment in time, thereby bringing a practice approach to a transition in water systems at the micro level of a sociotechnical system (Geels, 2002). Scholars such as Shove and Walker (2007) and others involved in researching practices, tend to be interested in *the trajectories of practices-as-entities,* as well as the performances by which these are formed and tend to look beyond specific moments of integration. The interesting perspective this research captures is the particular moment and situation in time: the moment residents are introduced to novelty and how they respond, adapt and negotiate the use of the system in relation to their existing everyday socio-material practices.

Within the site of this niche experiment there is no assumption that findings can be easily extrapolated to other situated user groups, but rather that end-users' insights provide details about how the social and technical parts of a technological system are negotiated. This reveals a range of potential challenges to the adoption of innovation including how innovation itself is conceived. In commissioning social research and acting upon research findings, the water utility created a mutual learning opportunity. They also provided ongoing technical support and a designated helpline for residents. However, this research also enables us to speculate on how social research might be better integrated into processes of water management beyond the feedback loops established by mechanisms such as technical support, helplines or interim progress reporting by the researchers.

We propose that social research that takes into consideration the interaction between participants models a process of social network building that needs to occur well before the implementation of a system commences, so that residents can discuss concerns, raise questions and participate in the tailoring of the system. In some ways this particular community was less alienated from biophysical nature than is conventionally anticipated in the design of new systems (Kaika, 2004). For example, the importance of the rainwater tank in established on-site water management practices directly challenged the viability of the high-tech recycled water system and led to its rejection in this trial. This might have been better negotiated through a social network enabling end-users to have a say in how innovations proceed and in mediating technological change more broadly.

Social practice researchers could have an important role in facilitating such a network and supporting residents who have agreed to trial innovative new systems. In the context of the need for massive change in big systems like sanitation and water, the delegation of change agency to motivated social groups could, we suggest, lead to greater success in establishing more sustainable systems. This research is posited as a first stage investigation to determine how viable an innovative system is in practice in the protected space of a niche experiment.

There is much that can be learned from capturing this moment of situated practice to support the innovation process. In agreement with Schön's (1983) statement that we know in our action, people are expert-users of their own knowledge and the process of actually trialling innovation. The ways in which users negotiate everyday practices by mobilising materials, skills and meanings, and establishing new practices provides the greatest insight for practitioners aiming to facilitate transitions toward sustainability. Engaging household water users in the process of trialling innovation brings to the forefront the challenges and opportunities of system change before investing in scaling up potentially incompatible systems.

What tends to be missing in planning for system change is the appreciation that historically derived patterns of water use and locally distinct socio-cultural contexts have the potential to influence the successful adoption (or not) of novel technological systems in practice. A water system designed for a generically defined end-user, devoid of historical, cultural and emotional meanings associated with water use (see Moy & Fam, in press), misses human centred issues influencing its success. Although the investment in social research for this trial was a significant step forward in acknowledging socio-cultural influences in system change, social research, or more specifically engagement with users of innovation, is ideally required before technology selection has been made to provide insight into appropriate technology suited to situated community practices. This practice-based approach to system change requires diverging from deeply embedded technological biases in water planning and recognising the importance of understanding the 'socio' in socio-technical change.

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