Journal of Cleaner Production xxx (2016) 1–7

Contents lists available at ScienceDirect

Journal of Cleaner Production

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

The ambiguity of innovation drivers: The adoption of information and communication technologies by public water utilities

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ARTICLE INFO

Article history:
Received 15 June 2015
Received in revised form
2 June 2016
Accepted 1 August 2016
Available online xxx

ABSTRACT

Information and communication technologies have the potential to increase productivity, improving efficiency and eventually raising the quality of water services. Although this potential is recognized, great variation exists in the way water utilities adopt information and communication technologies.

Based on literature review and empirical data drawn from the three case studies (a municipality in Greece, an airport in Italy and a water utility in the Netherlands) developed under the EU-funded Waternomics project the paper highlights how environmental, organizational and individual factors explain technology adoption. The paper pays particular attention to the idiosyncrasies of the water services sector, which influence this process. These include include the social and conomic importance of water supply, the monopolistic nature of the sector and increased commercialization of public water utilities. Our cases suggest that drivers of technology adoption appear to be somewhat ambiguous in the water services sector, in that they impact adoption in diverse locations differently. Our cases also suggest is that the prioritization of the factors that determine adoption are dynamic and change over time.

1. Introduction

In a world where the quality and quantity of available fresh water resources is threatened, the importance of effective management of water, from source to tap, increases. Although urban water supply does not, in general, account for a large percentage of the total fresh water use,[1] it is estimated that water demand for urban uses (and subsequently its related abstraction rates) will increase at a higher rate than population growth rates (OECD, 2005). High rates of water abstraction are usually exacerbated by leakages or other distribution losses.[2] In the European Union leakage levels vary from up to 50% in Bulgaria to 5% in the Netherlands. The European Water Stewardship (n.d.) points out that London has water losses of 35% and some Italian cities even record unaccounted for water levels of up to 70%.

In recent years the development and implementation of smart water systems has been promoted to reduce water losses in urban water provisioning. Smart water systems incorporate new types of smart sensors to gather data for improved advanced analytics, which allows the utility to rapidly detect leakage patterns by providing real-time information about the system. In addition, such smart systems provide real-time information on consumption patterns and incorporate innovative demand forecasting technologies (ITU, 2010). Information and communication technologies (ICTs) represent an important element of smart water systems.

Despite the apparent benefits and advantages related to the implementation of ICT in water (services) (Barba-Sanchez et al., 2007), we explain in this paper that the adoption of innovative processes (or ICT) in public water utilities follows different speeds depending on the particular situation of the water provider. As such, the adoption and willingness to innovate has not followed a recognizable pattern across the water supply sector. The nature of the water services sector, and especially, the context in which public water utilities develop play a significant role in explaining

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[1] The FAO (2014) suggests that on average 23% of water is used for domestic/industrial purposes and 59% of water for agriculture. Significant differences between countries do exist.

[2] Reduction in consumption levels, on the other hand, are usually linked to awareness campaigns, the introduction of metering systems or increased water tariffs.

http://dx.doi.org/10.1016/j.jclepro.2016.08.002
0959-6526/

how theories of innovation do not always seem to be able to explain adoption of ICT or the willingness of public water utilities to innovate. By drawing on innovation studies, this article analyzes determining factors that play a role in understanding innovation processes and ICT adoption in water utilities.

This paper is structured as follows: we first provide a brief introduction to the many uses of ICT in water (management) and we elaborate on the nature of water services sector. These two sections describe the context in which water utilities operate. After the methodology section, the article elaborates on the determining factors that play a role in innovation and ICT adoption in the water (services) sector. The article finishes with an elaborated discussion on the sector characteristics for understanding innovation in water utilities.

1.1. ICT and water

According to (Ollo-López and Aramendía-Munet, 2012: 204) "ICT has come to be a fundamental pillar of the knowledge economy, providing a possible answer to overcome drawbacks of conventional systems". Also in organizational management literature ICT is receiving considerable attention because of its potential contribution to efficiency improvements (Hilty et al., 2006 in Ollo-López and Aramendía-Munet, 2012: 204). The possible benefits of the adoption of ICT lie in the positive impacts on productivity rates or because ICT influences the flexibility of organizations by providing additional knowledge about the organization's own systems or consumer behaviour (Vilaseta et al., 2006 in Ollo-López and Aramendía-Munet, 2012). By providing such knowledge ICT is able to influence the intermediate business processes and ultimately organization goals such as service quality, cost savings, or customer satisfaction management (Tarute and Gatautis, 2014: 1223).

For water utilities, ICT has brought new possibilities of acquiring and integrating data in already existing systems. Examples of these are smart meters, network sensors or smart pipes that allow utilities to have remote (and real-time) access to the functioning of their systems (including water consumption by customers). Utilities are increasingly better able to connect to their customer base through web-based communication tools or smartphones. In the water sector examples of 'citizen observatories' have been developed to report water levels and to disseminate information concerning water related risks (Wehn et al., 2015).

Despite an extensively developed body of literature discussing the benefits and attributes of incorporating ICT in a given company's business processes, ICT adoption has not developed homogenously. This heterogeneous adoption also characterizes the water services sector. In this article we explore this heterogeneity by examining drivers of ICT adoption by public water utilities. In the following section we highlight some of the peculiarities related to water services, which contribute to explaining the differences of ICT adoption by public water utilities. In subsequent sections we elaborate in more detail how factors usually identified as relevant for innovation adoption in any industry need to be nuanced or reinforced when analyzing innovation and ICT adoption by water utilities. By doing this, we aim to contribute to understanding innovation in public water utilities, which has received little attention in the past.

1.2. The nature of the water services sector

The characteristics of the water services sector influence the degree to which ICT adoption takes place. The first, and most often highlighted, characteristic of water supply is that water is a vital resource. As highlighted by (Savenije 2002:742), "there is no human activity that does not depend on water". Because of this intrinsic value of potable water, utilities deal and operate in an environment that emphasizes reliability of service. Most utilities have a mandate that stipulates the provisioning of potable water in sufficient quantity and of good quality, without exceptions. In order to do that, water utilities tend to opt for operational structures, technologies and infrastructures that support this mandates. Water utilities require to be reassured that a technology has been tested and proven before they are willing to apply these technologies. As a result, in most European countries the water services sector is characterized by over-engineered systems aimed at minimizing the risk of service delivery failures (Blokland et al., 1999).

A second characteristic that influences the adoption of technologies concerns the amount of investment required to develop water production systems and distribution networks. Once in place, fixed costs of potable water generation usually account for 75–80% of the total costs of supplying water services (Noll et al., 2000). These investments are generally concentrated in pipes and treatment plants that have no other possible use than that for which they have been designed. The infrastructure developments for water supply are usually static and designed to serve the projected water demands with horizons of 25–30 years allowing for few modifications to the systems in between design periods. This results in an infrastructural fix in which a particular decision on the type of technology and infrastructure largely shapes water services provisioning for a period spanning multiple decades.

A third characteristic of water utilities concerns the monopolistic nature of the market once the infrastructure for service provisioning is in place. As monopolists,[3] these utilities do not experience competitive pressures from other water companies. At the same time, the market for potable water is relatively stable with limited growth in developed economies. The absence of these competitive pressures,[4] combined with a stable market provide little incentive for water utilities to develop innovative approaches to the provision or water, as long as they provide reliable, efficient and adequate services.

Whereas the above-mentioned characteristics suggest low rates of innovation and ICT adoption, the water services sector has been subject to institutional changes in the 1990s and 2000s, which promote innovation. Traditional engineering-oriented water utilities have increasingly been pressured to become more commercial and customer-oriented. The commercialization of public water utilities, referred to as a 'second wave of neoliberalism' by Smith (2004), has since become the dominant mode of reform in the water services sector. In this approach, public water utilities are requested to operate as autonomous companies on the basis of full-cost recovery, be entrepreneurial and strive for ever more efficient utility operations through elaborate systems of performance management. Public water utilities thus not only have to ensure reliable provisioning of a vital resource, but also have to address commercial objectives. This duality has been referred to as the 'confused identities' of public utilities (Loftus, 2004:73) and 'the schizophrenia of public enterprises' (van Rooyen and Hall, 2007: 60). The more commercial orientation of public water utilities has also impacted the functioning of these organizations. Whereas public utilities once emphasized technical service provisioning and technical knowledge, in the past decade they appear to have invested considerably in customer management and the

[3] Although ideas of common carriage competition have been raised, they have so far not been applied extensively in the water sector (Spiller and Savedoff, 1999).

[4] In recent decades the use of benchmarking as a tool for creating 'quasi-competition' is increasingly applied as a way of trying to simulate competition between utilities.

Please cite this article in press as: Tutusaus, M., et al., The ambiguity of innovation drivers: The adoption of information and communication technologies by public water utilities, Journal of Cleaner Production (2016), http://dx.doi.org/10.1016/j.jclepro.2016.08.002