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Title: The water Utility Adoption Model (wUAM): Understanding influences of organizational and procedural innovation in a UK water utility

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Abstract: For UK Water and Sewerage Companies (WaSCs), the capacity to innovate capital investment processes, and consequently performance outcomes is fundamental as they seek to deliberately change infrastructure to improve the sustainability of service delivery within a comparatively regulated framework. Innovation is viewed here as being either incremental or radical changes to the products (services) and processes (ways of delivering services) which are typical to the organisation (WaSCs). Product and process innovations may involve changes to some or all of technologies, organisational structure and processes, behaviour and culture, and knowledge and skills within the organisation and its supply chain. This paper sets out to provide an understanding of the factors which both enable and constrain the development and adoption of infrastructure investment process innovations in the context of water utilities concerned with water and sewerage service delivery. The paper documents the process and results from an inductive research programme of participatory action research undertaken within a large, privately owned UK WaSC to facilitate infrastructure investment process innovation. Employee narratives during the innovation process from initiation to adoption decision-making were characterised and analysed. The findings suggest that the development and adoption of asset investment process innovations tends to be skewed in favour of opportunities which align with (i) UK and European Union legislative and regulatory drivers; (ii) WaSC mission policy and goals; (iii) innovation cost advantages over a prescribed period of time; (iv) perceived risks to service provision associated with the introduction of the innovation, and; (v) the extent to which the organisational processes and cultures which act to increase the absorptive capacity of the WaSC to the proposed innovation are already functioning.

1 Introduction

The UK water industry is a largely privatised geographical monopoly comprised of a set of companies providing either water supply services (WoCs - Water only Companies) or water supply and sewage conveyance and treatment services (WaSCs – Water and Sewage Companies). The companies are heavily regulated in terms of water, environmental and economic performance and operate under a pseudo-competitive framework overseen by government. For the WoCs and WaSCs which comprise the majority of the UK water industry, sustainability and sustainable development represent a multitude of challenges. Demographic and environmental changes are reducing access to, and availability of, fresh water resources in many parts of the country (EA, 2011). Regulators are demanding ongoing improvements in the quality and efficiency of services; increasingly stringent conditions for emissions to water, air or land (Water UK, 2008); catchment-specific management of the water environment (Chave, 2001), and; the adoption of long-term planning horizons (Water UK, 2008). At the same time the unit costs of input energy, materials, chemicals and manpower, and the management costs of reducing process by-products continue to rise (Clark *et al*., 2000, Palmer, 2010).

Clear and consistent drivers for innovation to incorporate sustainability principles into infrastructural asset investment decisions and operational practices can be seen within the UK water industry regulatory structure (DEFRA, 2002,UK Gov, 2003). Since 2001 the industry has voluntarily began to develop and report against a set of sustainability indicators (Water UK, 2013). These indicators suggest that progress is uneven although it is accepted by the water industry that responding to the challenges of sustainability will require significant innovation (Ofwat 2010, DEFRA 2011, UKWRIF 2012).

However, per year total R&D spend for all UK WoCs and WaSCs fell from £45 million pounds in the late 1990s to £18 million by 2008 (CST, 2009), representing an industry investment of just 0.5% of annual turnover. With decreasing R&D spend, assessments of the industry have found 'a significant potential to increase … innovation intensity' (Thomas and Ford 2006) with the gap between innovation need and innovation performance across the industry referred to as a crisis (Thomas and Ford, 2005) and an 'urgent need for step-changes' called for (CST, 2009).

So, what do we know about how innovation might be more successfully stimulated and managed across the water utilities (WoCs and WaSCs) that comprise the UK water industry? To answer this question we can seek answers from the general literature on organisational innovation (OI) theory, and from empirical research on water utilities specifically. This paper provides insights from both avenues of enquiry.

First, the paper presents a review of relevant innovation (see section 2) before explaining the research design, method and phased structure (see section 3). Results from a detailed empirical investigation into innovation processes within a particular WaSC in the UK are then provided in section 4 before the relationships of these results to existing literature on organisational innovation are discussed in section 5. Finally, a set of conclusions and recommendations are provided in section 6.

2 Theory

A large volume of general OI literature has been produced (Crossan and Apaydin 2010) and can be broadly thought of as covering three themes – *context*, *content*, and *process* (Poole and Van de Ven 2004). Innovation *context* relates to environmental characteristics both internal and external to the organisation (Zaltman et al. 1973) that may influence innovation outcomes; *content* refers to the nature of the change (the innovation characteristics), whilst; *process* refers to the actions undertaken and events which occur during the enactment of organisational innovation and the logic or drivers behind them. Fig. 1 (below) presents a characterisation of the relationships between innovation content, context and process synthesised from the OI literature.

A number of studies have shown that OI is partly a consequence of characteristics of the environment external to the organisation. For example, the rate of technological and market changes (environmental uncertainty) and the number of technological and organisational interdependencies (environmental complexity) encourage innovation adoption through a sector (Tidd (2001), as does the level of knowledge sharing and networking among parties with complimentary capabilities (Romijn and Albu 2002), and the intensity of networking activities (Pittaway et al 2004) found in a sector. Regional models of innovation seek to explain the innovation dynamics of organisations as resulting from a series of regional attributes such as proximity and networks that can enable, facilitate and encourage innovation (Simmie 2005).

A wide range of internal characteristics of organisations have been demonstrated to influence innovation outcomes (Damanpour 1991, Lam 2004) including type (e.g. non-profit or profit; service or manufacturing) and size (small or large) (Camison-zomoza, Lapiedra-alcama et al. 2004). Beyond typologies of organisations, the lowest level of internal analysis relevant to OI is that of the individual (employee). Anderson et al. (2004) reviewed individual level determinants of OI outcomes and found twenty-four different features, which they categorised under five types of determinant - personality, motivation, cognitive ability, job characteristics and mood states. At a group or team level nineteen different features of work groups were identified and categorised into a further five types of determinant - leadership, membership, climate, process characteristics and structure (Anderson et al,. 2004). These individual and group level determinants surrounding innovation are influenced by institutional influences including norms and learned, tacit knowledge (Nightingale 1998). They are also influenced by and in turn influence a range of organisational level characteristics such as the complexity of the organisation, the degree of centralisation, the availability of (slack) resources, the effectiveness of communication within the organisation and from the external environment into the organisation (Damanpour 1991, 1996, Lam 2005).

Beyond context it has been shown that an innovation's characteristics (e.g. type, scope, magnitude, and form) may have an impact on its effectiveness, or on an organisation's capacity to assimilate it (Crossnan, 2010). The relationships between innovation content and context will determine whether or not the innovation will be adopted, and in what form. A number of models have been developed and applied to organisational innovation to describe these relationships and how they might play out, including as Ajzen's (1991) Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM) originally by Davis (1989). The various versions of the TAM which have been developed since 1989 suggest that OI uptake and impact is mediated by the characteristics of an organisation, the external organisational context and their relationships to the characteristics of the innovation (Venkatesh and Bala 2008). The 'relative advantage' of an innovation (Davis 1989), the complexity and the difficulty the subject has in understanding/using the innovation (Thompson, Higgins et al. 1994), and the compatibility with the existing values/past experiences and needs of the user (Moore and Benbasat 1991), are all perceived in relation to the existing system and the new practices associated with the innovation.

A number of authors have sought to distil these models further to describe critical relationships or process activities that must be managed to encourage innovation adoption in organisations. For example Klein and Knight, (2005) propose the following key determinants are required during innovation implementation: managerial support, financial resources, learning orientation of the organisation and a positive climate. Armenakis and Harris (2009), argue that the most important 'sign post[s]' for adoption and successful OI outcomes are recipients' motives to support adoption, namely:

- Discrepancy: a belief that there is a significant need for change
- Appropriateness: that the change proposed is correct to address the discrepancy
- Efficacy: the belief in the capacity of the recipient and organisation to implement the change
- Principle: that there is suitable buy-in from leadership for the change
- Valence: the belief that the change is beneficial to the recipient

Ultimately OI can, in general terms, be seen as a socially constructed process from the perceived need for innovation, through content and context to process outcomes. Individual, group and organisational level determinants of OI are influenced by the history, specific skills and knowledge network of the individuals involved (Romijn and Albu 2002). This creates a complex, dynamic mix that can influence outcomes in a diverse range of ways.

Crudely, OI literature (Burke, 2011, Epstein, 2008) suggests that building sustainability into practice within a water utility will require change in not only technology, structure and process at organisational scale, but also in behaviour, culture, knowledge and skills (Blackmore and Plant, 2008, Burke, 2011, Cashman and Lewis, 2007, Epstein, 2008). However, despite there being good general understanding of the factors influencing the adoption and diffusion innovations for cleaner production (Montalvo, 2008, Kemp and Volpi, 2008) little is known about how those factors influence OI processes in water utilities.

What is known about water utility innovation adoption and diffusion exists in a relatively small literature focussing mainly on analyses of adoption processes situated at the organisational population scale (e.g. Spiller *et al*. 2012,). From within the UK, the UKWIR report, 'Barriers to Innovation in the Water Sector' (Thomas and Ford, 2006), found that innovation adoption was affected by risk averse attitudes, strategies and purchasing policies of water companies with water utility 'research and skills base' and 'approach to risk/novelty' the strongest barriers to innovation. Spiller et al. (2012) found economic regulation, long-term regulatory uncertainty, technology lock in, a lack of knowledge about new and emerging technologies and the different ways in which organisations framed problems and opportunities were key barriers to innovation in the UK water industry. Spiller *et al*. (2015) found that regulatory and legislative drivers (like the EU WFD) could help create an awareness of the need to innovate amongst water utilities, and to some degree to help shape the sets of options for innovation evaluated by water utilities, but that water utility innovation was complex and locally contingent.

Focussing on the Australian urban water sector, Brown and Farrelly (2009) identified deficiencies in the institutional framework, and the division of roles and responsibilities as significant innovation adoption and diffusion barriers. Looking specifically at utilities, Herrick and Pratt (2012) identified a matrix of organisational characteristics which influence propensity to innovate including (i) ability to craft and communicate a compelling narrative, (ii) a willingness and ability to diffuse authority, and (iii) an adaptive or learning-oriented outlook which enables movement towards more sustainable operations.

No research to date has sought to understand innovation with regards the processes through which new water utility infrastructure (or assets) are designed and constructed, although the importance of capital investment financial and technological lock-in to either enabling or preventing innovation diffusion is well recognised (Kemp and Volpi, 2008, Spiller *et al*. 2012). In response, this paper provides a case-study based empirical contribution to what Kemp and Volpi (2008) term adoption analysis of an unexamined area of water utility OI – asset investment and delivery.

The aim of the research is to better understand the factors which influence the implementation (or adoption) of innovations to the business processes through which new infrastructural assets that will improve the sustainability performance of the WaSC are designed and constructed. Adoption decision making is one of the middle stages of OI as articulated by Wolfe (1994) (see Fig. 1). More specifically, the objectives of the research are to provide answers to the following questions:

1. What factors influence a WaSCs selection and adoption of organizational innovations focussed on (infrastructural) asset planning and delivery? And,
2. What management recommendations can be made which would increase the adoption and use of such organizational innovations by WaSCs?

Our research focuses on a single UK WaSC and its Asset Delivery Unit (ADU). At the time of the case study, the ADU was responsible for delivery (design, construction, and commissioning) of a portfolio of £1.9 billion of new infrastructure (or capital) assets to resolve identified service risks and legislative drivers over the period 2010-2015. The ADU employs external organisations (the WaSC asset delivery supply chain) selected for their skills in infrastructure design and construction, and to commission new assets.

The research findings are expected to be of value to scholars focussed on better understanding how to achieve improvements in water industry sustainability, to water industry practitioners concerned with implementing asset planning and delivery innovation and to improving sustainability, and to Government departments responsible for generating the policy and regulatory settings within which water utilities must operate. The results presented here provide rarely documented insight into innovation adoption processes from within a water utility.

3 Method

The research approach follows an inductive strategy where data collection occurs without prejudice to theory – our aim was to approach understanding innovation adoption within the WaSC without preference to a particular theoretical perspective from the outset. Inductively gathered data is classified to identify underlying mechanisms to explain observations (Blaikie 2007). The research method was based on participatory action research (PAR) (Greenwood et al., 1993) applied to and undertaken as part of a broader engaged scholarship (Van de Ven 2007). This enabled the research to actively pursue the generation of knowledge to improve practice whilst involving the recipients of the research (members of the ADU) and subjects within the change community (the broader set of WaSC employees).

One of the authors was embedded as part of the Asset Delivery Unit (ADU) within a large (serving > 2 million households) UK WaSC for a period of 30 months. Within that time period the author was responsible for co-designing and piloting a series of organizational innovations with respect to the asset investment planning, design and construction business processes employed by the WaSC, and particularly those within the ADU.

The research was carried out in four stages as shown in Fig. 2. Briefly, phase 1 involved the selection of an innovation development methodology to use to develop process innovations within the ADU, along with the selection and interpretation of a sustainability framework to use as a guide in developing those process innovations. The innovation development methodology was applied within phases 2 and 3 of the research to collaboratively identify, develop and propose a set of process-focussed sustainability innovations to the ADU. The final phase, phase 4, involved analysing qualitative data from workshop and interview transcripts held across the first three phases to answer the two research questions to generate understanding of innovation adoption which can be utilised to improve sustainability innovation adoption rates and effectiveness across UK WaSCs.

A PAR innovation development methodology called 'Effective Technical and Human Implementation of Computer-based Systems' (ETHICS) (Mumford, 1983) was adapted to provide the basis for the work of phases 1 to 3. The benefit of the ETHICS approach is direct input from those likely to be affected, supporting and orchestrating the innovation. The resulting outputs are likely to generate greater buy-in and more user sensitive innovations. Practically, the ETHICS method was employed by the author to guide a series of workshops and focus groups with the objective of developing and identifying ways of changing the business processes through which new assets are designed and constructed.

3.1 Phases 2 and 3

To identify OI opportunities for the ADU the research engaged with WaSC employees and their supply chain partners through a series of workshops, focus groups and interviews, structured according to the stages of the ETHICS method (1983). For phases 2 and 3 the research employed purposive, snowballing and convenience sampling strategies (Given, 2008). Purposive sampling was undertaken to ensure a continuity of participants over the course of the innovation design processes, and to ensure designs incorporated cross departmental boundary issues.

Snowballing and convenience sampling as participant attendance was subject to competing work pressures.

Table 1 shows the set of employees involved in the innovation design processes and how they were distributed across different departments and hierarchies (tiers of management) within the WaSC. There are six management tiers with level 2 being the highest level represented (General Management – immediately below Director level) to 6 which represents administrative support staff. Over the whole research process we engaged in data recording activities with over 57 employees of the WaSC. These activities produced over twenty-two hours of digital audio recording for transcription, and multiple research diary entries and reflexive notes.

A detailed account of the innovation processes (from initiation to evaluation of the innovation adoption decision for the sustainability innovations) was maintained including digital audio recordings of all workshops, focus groups and interviews, the materials used and a detailed research diary.

3.2 Phase 4

The qualitative data produced from research phases 2 and 3 was analysed to answer the research questions and to develop the wUAM water Utility Adoption Model (wUAM) as a construct to explain OI outcomes in process and factor terms. The research design used for this study assumes that innovation adoption can be reliably studied by means of understanding the thinking of the actors involved. It is through a close analysis of the way in which these actors think, as revealed through their accounts, that a better understanding of the factors that influence sustainability innovation adoption can be achieved. Narratives are used by people as templates for planning and enacting activities (Czarniawska-Joerges, 1997) and in making sense of the world (Weick, 1995). Narratives employed within organisations may not only represent a historical account of events, but may also act like ‘ruts in the road’ (Pentland, 1999, p.712), forming part of the cultural fabric of the organisation. For example, a common narrative maybe that ‘we (the WaSC) change very slowly and are very cautious when adopting’. This narrative may influence the behaviour of employees who wish to conform to the WaSC’s *modus operandi*, and so the narrative becomes a factor which influences adoption.

In drawing on the narratives from multiple sources surrounding sustainability innovation, the research then reflects a shared account of the logic behind innovation adoption successes and failures, assuming the accounts are honest and reliable, and also that the research sample provides a representative account of prevalent narratives in the organisation regarding innovation experience and adoption decisions.

The following analytical tools were applied to analyse the data gathered to structure and reveal actor thinking - narrative analysis, thematic content analysis (Grbich 2007), axial coding (Corbin and Strauss 2008) and conceptual mapping. Nvivo (2011) was employed to facilitate thematic and content analysis and axial coding. To test and validate the narrative accounts the data was triangulated. Evidence from multiple sources, different participants, distinct research activities, non-verbal sources such as organisational work-flow-charts, policy and strategy documents and sector reports and statements were utilised to triangulate recorded verbal data (Given, 2008, Silverman, 2005).

Themes (common components of narratives) were identified from the range of narratives. From these a conceptual map (the wUAM) was synthesised to organise, present and articulate the set of factors that influenced innovation development, selection and adoption within the ADU (according to the perspectives, perceptions and thinking of the actors involved).

4 Results

4.1 Innovation opportunities

Following the ETHICS methodology, during the thirty months of the research within the ADU many process-oriented innovation opportunities were proposed/initiated by the embedded author, from a complete redesign of the whole asset delivery process and logic to the following ten discrete intervention options (see Table 2 below).

In total the research design group and project steering group supported the development of four of these innovations (numbered vii, viii, ix and x above) up to a point where they were formally proposed to the WaSC for an adoption decision. These four innovations were the subject of further interviews and focus groups which explored the WaSC adoption decision-making process.

4.2 Factors that influenced the selection and uptake of sustainability innovations

The research found the narratives on adoption of organizational innovations were commonly based on one or more of the following 17 components (see Table 3). These components were used when justifying a decision to proceed or halt innovation adoption, or when relating a story of past adoption success or failure.

The 17 narrative components were aggregated into domains – sets of components which influence WaSC adoption processes and outcomes:

- Alignment with properties of the WaSC
- Alignment with chronological events
- Financial constraints and drivers

- Impact on service provision

Each domain represents a narrative theme that was commonly employed when framing innovation adoption decisions. These domains are presented graphically in the water Utility Adoption Model (wUAM) (Fig. 3) with their associated narrative components, a description of how the domains relate to components and how those components were used in discourse within the WaSC to argue for or against particular innovations. The wUAM also signifies whether the narratives employed describe a time bound ***event*** (**e**) that would influence innovation adoption or was resulting from the fit or ***relationship*** (**r**) between characteristics of the innovation and properties of the WaSC. The wUAM domains suggest that adoption of organizational innovations was commonly expressed as a function of the following: Alignment with properties of the WaSC; Alignment with chronological events; Evaluation of financial constraints and drivers, and; Evaluation of impact on service provision (see Fig. 3). These results are discussed below and compared with the findings of previous research into innovation in organisations and innovation in the water industry in particular.

5 Discussion

5.1 Alignment to properties of the WaSC

In terms of the relationship between the innovation and the properties of the WaSC, the following factors were identified as influencing the selection and adoption of sustainability innovations: ‘leadership, mission, visions & policies’, strategies, ‘roles and responsibilities’ and resources.

5.1.1 Leadership (mission visions & policies)

The research demonstrated that the alignment of leadership support, organisation vision, and policies to the sustainability principles had an impact on which principles were incorporated into WaSC decision making.

The findings that leadership (Gerstberger and Gromala, 2009, Herrick and Pratt, 2012, Tidd *et al*., 2005, Frambach and Schillewaert, 2002,), shared vision (Burton Swanson and Ramiller, 1997, Lueke, 2003), compatibility with existing values (Rogers, 2003, Tidd *et al*., 2005) and/ or perception of management support (Leonard-Barton and Deschamps, 1988, Zhang et al, 2013) are important to successful innovation outcomes are supported by the academic literature. Of WaSC leadership Herrick (2012) argues transactional and transformational skills are required to develop compelling narratives and visions that generate engagement across the utility. Klein and Knight (2005) state without demonstrable management support employees will believe the innovation to be a passing fancy. Klein and Sorra (1996) note that managers must throw their weight behind groups favouring adoption. Furthermore Brown et al (2006, p.416) identify political support as 'necessary for promoting organisational change by redistributing funding, facilitating broader community awareness, and maintaining professional and organisational momentum for innovation'. Similarly, support from champions within the WaSC has been identified as crucial to innovation successes (Brown *et al*., 2006, Herrick and Pratt, 2012, Thomas and Ford, 2005).

Worryingly, the early Water UK sustainability indicators included dedicated management responsibilities, which were later removed as it was argued that the indicator was of no value. In contrast, these findings suggest that sustainability innovation adoption for this water utility would be improved by aligning the responsibilities of managers (leadership) with decision-making authority with sustainability goals.

The literature suggests that WaSCs benefit from improved long term vision (Thomas and Ford, 2005), and from steering innovation towards societal needs rather than being driven by short term commercial or regulatory goals (Thomas and Ford, 2006). A long-term vision enables the WaSC to justify decisions that go beyond the requirements or expectations of the current context, contributing to its long term (societal, environmental or strategic) aspirations.

The historic low levels of innovation investment in the UK water industry has been argued as a key reason why incrementalism and technological lock-in is common. Companies having investment strategies based on short term planning that conform with regulations (Heather and Bridgeman, 2007), could result in sub-optimal assets in the longer term. None of the innovation opportunities generated in this research could be described as radical opportunities but they are representative of the kinds of micro-scale process changes within organisations that have the potential to change the way in which significant investment decisions are made and delivered. Generally, this research showed that in terms of asset delivery process innovations generally, the WaSC chose to adapt existing processes and incorporate sustainability objectives within them rather than develop entirely new processes.

The findings confirm the findings in the IO literature and are positive. These findings suggest that incorporating sustainability principles into this WaSC's visions and policies with leadership support will encourage and enable sustainability related change and innovation.

5.1.2 Strategies

When a proposed innovation ran contrary to existing strategy its adoption was inhibited. Verloop and Wissema (2004) describe the matching of the innovation to the business strategy as a 'toll gate', where if an innovation 'does not fit with the existing ways of seeing then it has a very poor chance of entering let alone surviving in the strategic portfolio' (Tidd *et al*., 2005, p.408). This occurs as strategy is causally connected to past events and experiences (Thomas and Ford, 2005) and is formed from organisational values, norms and logic (the process by which an organisation making sense of its experience). To minimise operational and maintenance errors the WaSC under investigation adopted a strategy of standardisation (replicating and optimising) water treatment processes with which they had positive past experiences. With this strategy, innovations to treatment processes conflicted with the strategy of homogenisation and were less likely to gain traction. Burgleman (1991) argues changes in organisational strategy making bring about organizational renewal (innovation). To encourage sustainability adoption processes the WaSC would benefit from adoption of strategies that enable radical innovation rather than those which may inhibit innovation, however inadvertently.

5.1.3 Roles and Responsibilities

Sustainability innovation adoption was also found to be less likely if the proposed innovations were perceived to transgress the existing organisational structure of the organisation, or deviate from pre-existing responsibilities. These findings resonate with the existing literature, which suggests that bureaucratic structures (typical of mechanistic organisations) work well in stable environments, but that organic structures - where employees are given greater freedoms in determining their tasks, roles and responsibilities - are better suited to cope with innovation and change (Damanpour, 1991,). Whilst successful organisations require both these qualities (Tushman and O'reilly 3rd, 1999), different periods may demand a different balance between mechanistic and organic roles and responsibilities (Tushman and O'reilly Iii, 1996). What Damanpour (1991) refers to as 'Organicity' (the ease with which an organisation can modify organisational routines and behaviours) may be an appropriate quality for organisations seeking to adopt organizational innovations. Brown and Farrelly (2009) found that responsibilities and unclear roles were a barrier to innovation adoption. Herrick and Pratt identified that 'meaningful levels of enterprise-wide collaboration and integration of operational practices and perspectives' (2012, p.265) (functional integration) and diffusion of authority were key to WaSCs incorporating sustainability innovations, to solve wicked problems. Clearly, to encourage opportunities for innovation adoption the WaSC under investigation would benefit from greater elasticity in roles and authority and increased functional integration, we can posit that this would reduce the likelihood of entrenched roles and responsibilities becoming a barrier to innovation adoption. This is supported by the OI literature in general and across a number of sectors, it is clearly one of a number factors that inhibit adoption for this UK WaSC which mirrors findings across a number of utilities in the Australian water sector (Brown and Farrelly, 2009) despite the variation in the nature of challenge found in the UK in contracts to Australia.

5.1.4 Resources

The research demonstrated that when the resource demand characteristics, departed from those readily available to the WaSC there was a barrier to the selection and adoption of the sustainability innovation. These resource characteristics are better separated into two fields, the financial and labour resources and knowledge & skills resources which are attributes of the labour resources. Both fields are required to support innovation adoption.

In terms of knowledge and skills resources, when the research proposed innovative changes to the engineering specification to reduce the environmental impact of concrete, distribution pipes and steel used in construction, a lack of knowledge regarding the alternative materials was cited as the justification for a decision not to pursue adoption. These findings are also borne out in the literature, which suggests that innovation may either build on existing competencies and skills or may render those competencies obsolete (Tushman and Anderson, 1986). The more radical innovations can result in 'frame-breaking', requiring the organisation to abandon institutional logic and behaviours (Tushman and Romanelli, 1985). According to Cohen and Levinthal (1990), knowledge-related experience enables an organisation to innovate and/or exploit innovation opportunities. Berkhout (2006) argues the adaptation approach is thereby shaped by existing core competencies. In terms of water sector innovation experience, Brown and Farelly (2009) found a lack of expertise and skills to be a barrier to the adoption of Sustainable Urban Water Management (SUWM), and Spiller *et al*. (2012) found a lack of technological knowledge to be a barrier. Herrick and Pratt (2012) suggest that WaSC's would benefit from new knowledge disciplines being employed, which is a view supported by Heather Cruickshank (2007) who argues, as a result of sustainability considerations, engineers need to 'embrace a range of additional skills beyond the engineering science they have traditionally relied upon to solve engineering problems' and this may be a problematic barrier to innovation. Findings of Corral (2003) suggested for the highly flexible In-Bond Industry in Mexico an organisation's willingness to invest in cleaner production would be reduced if regulatory pressures were introduced without the accompanying attitudinal changes or perceived technical facility to control the innovation.

The research findings also suggest that the availability of human, labour and financial resources influenced the adoption of the organizational innovations. When this research project proposed new treatment processes, the WaSC cited the additional financial and human resources required for operation/maintenance as a barrier. Innovations that were perceived to require additional resources in administration or support were less likely to be adopted. This finding is also substantiated by the innovation literature. Klein and Knight (2005) suggest that financial resources ‘enhance the likelihood of successful implementation’ when coupled with demonstrable management support. Tidd et al, (2005) state that allocation of finance is a pre-requisite to successful research and development, and Damanpour (1991) links the availability of human and financial ‘slack resources’ to the ability to embed and maintain the innovation.

Innovation adoption is therefore understood to be knowledge dependent, and to innovate requires a process of acquiring or creating appropriate knowledge and is also dependent on availability of financial and human resources. Zahra and George (2002) use the term ‘absorptive capacity’ of an organisation, referring to the availability to an organisation of relevant skills, knowledge and resources to recognise and exploit innovation opportunities. In accordance with existing research these findings suggest that the WaSC innovation adoption would benefit from improved absorptive capacity.

5.2 Alignment with Chronological events

In terms of the relationship between the innovation and the timing with which it is introduced to the WaSC the research found that innovation adoption is influenced by the relationship of innovation process timing to WaSC regulatory periods, organisational restructuring rhythms and contract-making events.

A number of authors have identified different ways in which timing can influence innovation. Orlikowski and Yates (2002) suggests that people draw on patterns of events through time which may require explicit force to challenge, for scheduling work through a week. Tyre and Orlikowski (1994) suggest that the innovation process is subject to ‘fits and starts’. While

Rogers (2003) and Orlikowski (1994) suggest that the value and or cost of innovation is not constant and will vary through time. A number of authors also seek to explain innovation by a confluence of conditions which includes time (Lutz *et al*., 2007) relating both to the internal and environmental innovation support requirements that enable innovation to take place (Adner, 2006, Geels, 2002, Sartorius and Zundel, 2005).

UK WaSCs are subject to annual and five-year asset management cycles termed asset management periods (AMP's), which are punctuated by a series of contractual and reorganisational opportunities. Similarly, occasional interdepartmental restructuring and reorganising processes which are carried out at various time intervals also present themselves as periods of innovation opportunity or barriers, together with associated uncertainty around job security and settling into new roles. Thomas and Ford (2006) note that the time scale of AMP periods could be experienced as either a 'weak barrier' or a 'strong enabler'. The Cave Report (2010) suggests that the 5-year AMP period is often too short to allow sufficient time for developmental and piloting requirements i.e. acts as a driver of incrementalisation. Thomas and Ford (2006) also suggest that contract strategies (i.e. partnering commitments relating to the supply of technical information) may be a barrier to external innovation opportunities. In these analyses, sustainability innovation adoption can be determined by these rhythms of restructuring events and contracts, the timing of the innovation in relation to these chronological events were experienced like windows that could lock in or lock out innovation. Because of the intensity with which business process were aligned and executed with in the regulatory time frames, the timing of innovation process had the capacity to alter the perceived relative advantage (financial burden) due to a change in the transactional costs of innovation adoption. This transactional costs may be better managed by decoupling some organisational processes form the regulatory framework or rearranging the regulatory framework. It may be other sectors are better arranged to reduce and limit variation in the transactional cost of innovation through time.

5.3 Evaluative Domains

The research suggested that the outcome of appraising an innovation is influenced by the fit between the innovation and properties of the WaSC, and that this includes meeting WaSC evaluative standards. Evaluative standards require that an innovation constitutes a sound financial argument that conforms to the financial drivers and demands of the WaSC, while also making a sound case in terms of the innovation impact (value) on service.

5.3.1 Financial constraints and drivers

This research found that perceived or expected costs, or cost benefit balance, influenced the WaSC's adoption of organizational innovations. Anderson and Narus (2004) found that economic incentives for innovation adoption should exceed the alternatives. Luken and Van Rompaey (2008) note that perceived high implementation cost is a key barrier to clean technology adoption. This view is also supported by Rogers (2003), who describes economic advantage as one dimension of a relative advantage. Relative advantage is 'the degree to which an innovation is perceived as better than the idea that it supersedes' (Rogers, 2003, p229) and is partly a function of economic cost-benefit comparison and judgement, but is also importantly influenced by perceptions of uncertainty around whether the economic balance of adopting an innovation might change for the better or worse as time progresses (Kemp and Volpi 2008). Moreover, a simpler traditional cost is based on economics and struggles to accommodate social and environmental benefits that are difficult to monetise. Afuah (2003) notes that having recognised the potential of an innovation that demonstrates economic advantages, an organisation must still find the finance to put together a team and formulate strategies to exploit innovation opportunities. Recognising the importance of economic advantage to water sector innovation, Thomas and Ford (2006) state that 'innovation fails to interest water companies until it offers significant commercial and strategic benefits' (Thomas and Ford, 2006, p.57). They proceed to warn that as a result of a focus on economic considerations, future strategic benefits can be overlooked.

The research reported here suggests that only those organizational innovations for which there was a clear and recognised opportunity for cost saving were selected for adoption. Where there was the perception of additional cost burden this was expressed as a barrier to innovation adoption. In the case of operational KPIs innovation, the research demonstrated that even innovations that were pursued on the basis of the potential to generate cost advantages may not ultimately be selected for adoption. More specifically, for those innovations that can generate clear cost advantages with minimal disruption to existing business processes are more likely to be pursued and adopted.

The organisational context and the WaSC environment are also able to place the innovation within the economic decision and thereby influence the perceived relative economic advantage. The research identified that market-based cost pressures and the regulatory framework can either augment or reduce the perceived economic advantages of the organizational innovations. Organizational innovations that fail to benefit from appropriate regulatory or policy framing and incentivisation are less likely to be adopted by the WaSC. (The regulatory system under which the WaSC operated stipulated that any cost benefit achieved through an innovation can only be retained by the company for a fixed period of time (5 years). After this it must be returned to customers i.e. as cheaper bills). Similar findings are found in the literature, where a number of studies have suggested that sustainability concerns can manifest as cost pressures to a WaSC, such as pressures from population growth, climate change, water and energy demand (Defra *et al*., 2008, Gleick and Palaniappan, 2010, Unesco, 2009). The literature also explores the role that the regulator plays in framing or generating the conditions which enable sustainability innovation adoption (APPWG, 2008, Cave, Michael, 2009, Legge, 2000, Smith *et al*., 2005).

One example, where a sustainability principle has been placed into the economic decision is carbon emissions trading, currently being ‘rolled out’ to support the UK’s carbon reduction commitments (Prescott, 2009). The launch of the UK’s Carbon Infrastructure Review in November 2013 increased the focus yet further by including targeted reductions in embodied carbon in the design and build of infrastructure assets (Gov UK, 2013). Similarly, triple bottom line accounting is also being encouraged (Kenway *et al*., 2007). However, these mechanisms may still fail to alter decision outcomes if the monetised value does not justify a change in practice Palmer (2010) and Sarwar (2008). Murovec et al. (2012) identified that environmental investment by organisations is influenced by a variety of policy measures that included regulation, tax and financial incentives.

The findings from this research suggest that rapid progress towards improving sustainability practice for the WaSC will come from innovations that benefit from, or align with, strong market forces (such as demonstrated here with KPIs innovations adopted for energy, waste and carbon) and or align to the regulatory rewards and penalties system.

5.3.2 Impact on Service provision

Finally, this research found that the WaSC under investigation required the innovation to demonstrate value in terms of risk and impact on service. The WaSC had adopted a risk-averse strategy for technology innovation, which reduced the opportunity for innovation to critical assets.

Frambrach, suggests that by reducing the risks (implementation, financial and operational) associated with early adoption of an innovation, 'innovation adoption can be stimulated' (Frambach and Schillewaert, 2002, p.166). Rogers (2003) refers to 'trialability' as an innovation characteristic that can influence adoption; an innovation that can be trialled can confirm or refute perception about the innovation and its adoption impacts. Organisational culture influences the way organisations respond to risk (Berkhout *et al*., 2006), and many authors believe that UK WaSCs have adopted risk averse behaviours and strategies, which they will need to depart from in order to effectively tackle sustainability (Cave, Martin, 2010, Herrick and Pratt, 2012, Thomas and Ford, 2005) .

In this highly risk averse water industry culture, the collection of relevant research and data to inform decision makers is increasingly important. Arguments have been made for data on benchmarking the best of sustainability (Thomas and Ford, 2005), for broadening the current narrow range of data used in decision making (Ashley *et al*., 2008) for moving from regulatory reporting of data into a decision making framework (Palme and Tillman, 2008), and for expanding existing tools to accommodate more data needs (Prescott, 2009).

This suggests that where the WaSC, through their past experiences of innovation, have become risk-averse, sustainability innovation will favour non-critical assets. However, where innovation is targeting critical assets, activities that reduce the perceived risk to the WASC will facilitate adoption. This study suggests that sustainability innovation to critical assets will be slow and will only occur in conditions of limited uncertainty.

6 Conclusions

Narrative analysis has enabled the research to identify stories that framed activities and positions concerning sustainability and organizational innovation within the Asset Delivery Unit (ADU) of a large UK Water and Sewerage Company (WaSC). For the WaSC, the selection and adoption of organizational innovations was limited to those that provided a clear cost advantage, which could be rapidly realised and immediately recognised. Selected innovations would therefore typically benefit from alignment to strong market forces and the regulatory framework of incentives and penalties. Furthermore, sustainability innovation adoption also favoured conditions where the organisation had established roles, responsibilities, skills or work tasks and had accrued knowledge and understanding closely associated with the innovation. Finally, innovation propositions would benefit if they satisfied the WaSC's cautious risk position.

The conditions described above suggest a skewed selection and uptake of sustainability innovation adoption, which favours a set of innovation opportunities limited by the organisation's strategies, policies and goals, the innovation cost advantages, chronological opportunities and the perceived risks to service associated with the innovation. Furthermore, rather than driving innovation, respondents believed that sustainability was attributed most often retroactively, after the innovation process had taken place. In these circumstances, the outlook for the UK WaSC to generate radical improvements to the sustainability performance through the adoption of organizational innovations is restricted unless some of the insights of water Utility Adoption Model (wUAM) can be translated into practice.

Future research should seek to further test, develop and refine the wUAM in the context of other water utilities (Water only Companies and WaSCs) within the UK and further afield. Doing so will reveal the extent to which different utilities vary in terms of innovation discourse and processes, and provide a broader and more robust basis for policy prescription at the level of the organisational population, and, if general Organisational Innovation (OI) features hold across utilities, provide an opportunity to use the wUAM as a platform for informing management action to improve OI outcomes and adoption success. Ultimately there is scope to contribute to better understanding OI management in the context of heavily regulated, privatised utilities which have so far not been studied closely despite their vital importance to societal function.

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Fig 1

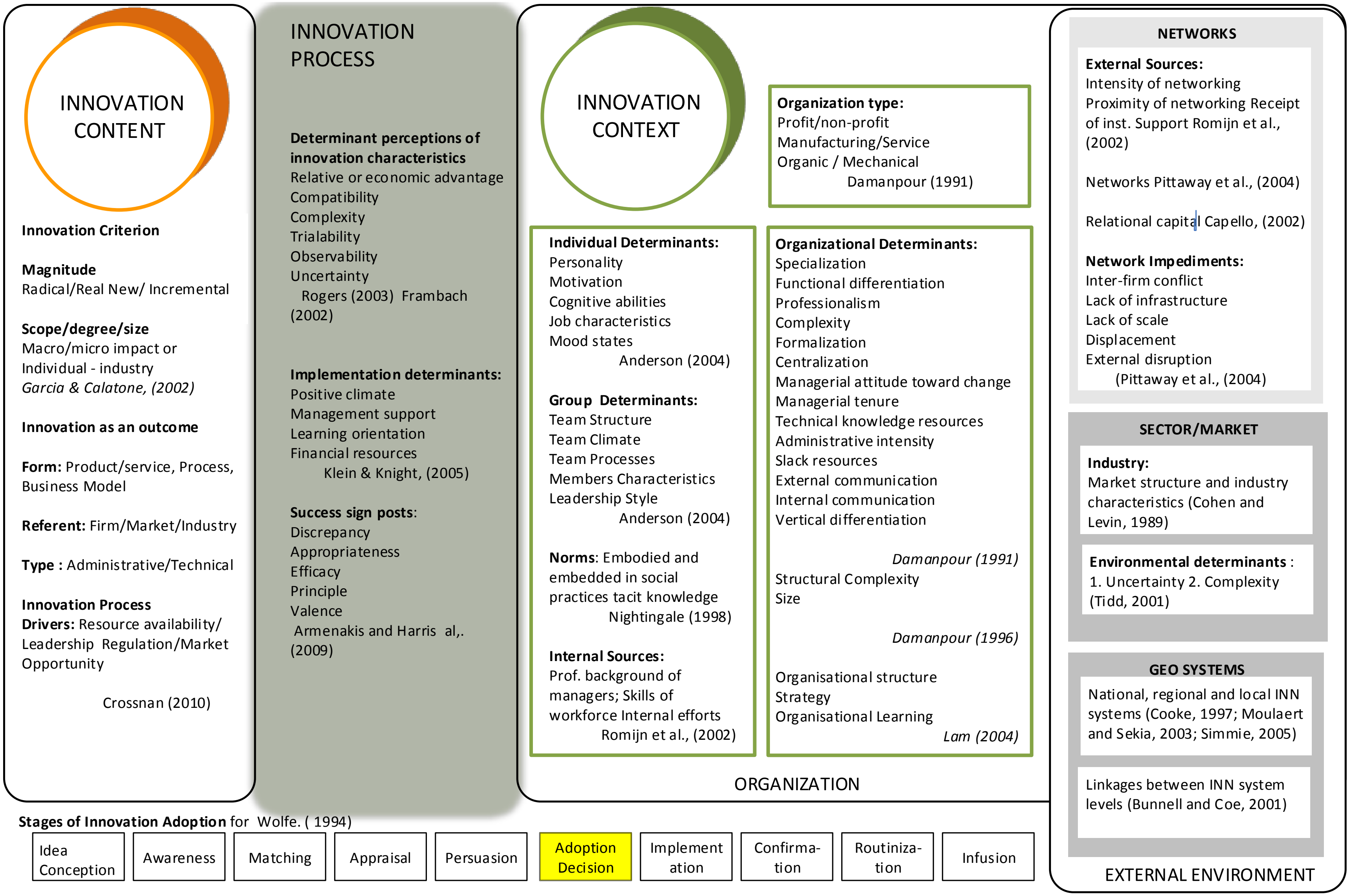

Fig. 1. Content and context determinants of organisational innovation process outcomes (adapted from Crossan (2010)

Fig 2

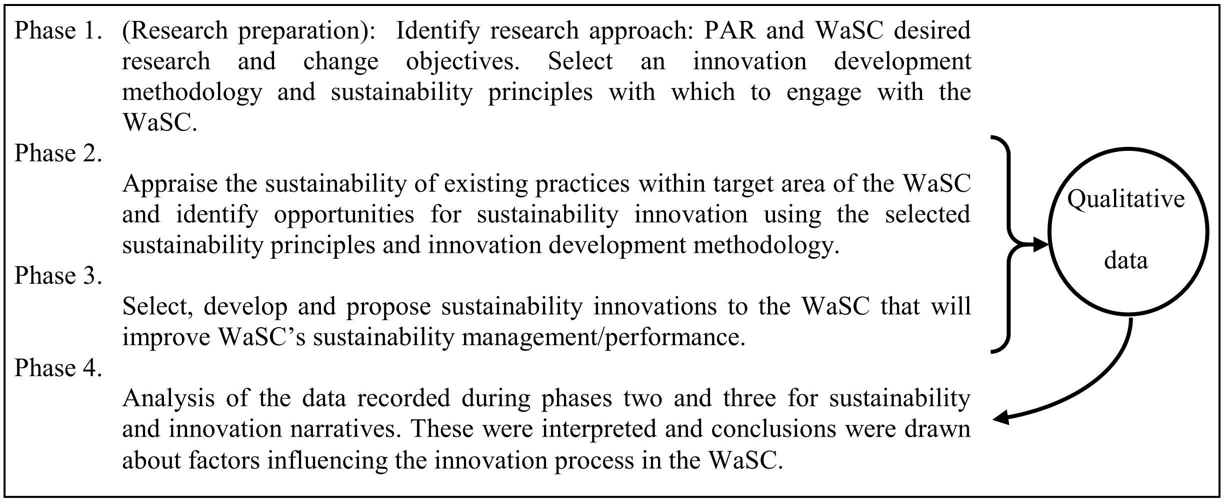

Fig. 2. Research phases and activities (PAR = participatory action research)

Table 1

Table 1 Sample size and distribution

WaSC Departments	Management Tier Distribution					Dept
	Tier 2	Tier 3	Tier 4	Tier 5	Tier 6	Total
Asset Delivery Unit	2	5	12	1		20
Production Unit	3	11				14
Regulation Investment Unit	2	8	5			15
Customer Services		1				1
Supply chain	1	2				3
Research & Development		1				1
Information Technology		1				1
External Consultants					2	2
Management Tier Total	8	28	18	1	2	57

Table 2

Table 2 Ten business process innovation opportunities presented to the WaSC Asset Delivery Unit

Innovation opportunities proposed/initiated	
i.	**Asset renewal selection:** This is the logic that underpins selecting an asset for renewal. The risks based management planning could deliberately select assets based on opportunities to improve sustainability performance.
ii.	**Asset renewal contracts:** This is a change to the contracts between the Engineering Partner Organisations (EPO) and the WaSC. The proposed contracts would identify sustainability performance as a concern of the WaSC that the EPO would be bound to address in delivery of new assets.
iii.	**Sustainability awards for contract partners:** This is an annual or biannual award for EPO's. It is awarded to the best EPOs for embedding excellent sustainability practices or technologies into the WaSC.
iv.	**Ways of working:** This is an innovation into the meetings and communications of the WaSC. Meetings and meeting plans with sustainability checklists would be incorporated into delivery review meetings between the WaSC and the EPO, to enter sustainability into the corporate culture and dialogue.
v.	**Leadership statements:** High-level leadership statements on the value of sustainability and its importance to the organisation. These statements are then to be promoted through the WaSC and to EPO's to influence their asset investment proposals.
vi.	**Infrastructure benchmarking:** this is identifying the best in class for any asset type to steer future investment decisions. The best sustainability performance from across any specific asset type either within the WaSC's existing portfolio or from across the world should be identified and used as a means to evaluate the suitability of EPO proposed asset infrastructure solutions.
vii.	**Large infrastructure contract:** This is a contract amendment/addition which would state the sustainability interests of the WaSC. This would require the submission of sustainability performance data for each large infrastructure proposal, and enable the WaSC to compare proposals on the basis of sustainability performance.
viii.	**Key performance indicators (KPI's):** This is enhancing the existing KPI's which are applied by the WaSC to assess the engineering partners on the quality of their delivery to include sustainability performance. The KPIs both signal and influence partners as to key business concerns. It was suggested that developing a set of KPIs based on the sustainability performance of the infrastructure might influence the EPO to improve sustainability performance of construction activities and of assets proposed it would also help the WaSC identify best practice.
ix.	**Asset option selection framework:** The Asset Standards (AS) is an appendix to the EPO contract. The document stipulates the infrastructure options available to the contracted engineering partners to resolve the infrastructure risk and the design specifications and critical design features of that infrastructure. The engineering partners are contractually obliged to adhere to the asset standards. Sustainability performance could be improved by changing the asset standards to improve the sustainability performance of the processes and technologies specified, removing poor performing technology types and adding technology types with better sustainability performance.
x.	**Material and construction option selection framework:** The Engineering Specification (ES) is an appendix to the partner contract. The document stipulates suitable materials for any given

	function and context, and the handling and construction methods associated with stipulated materials. Sustainability performance could be improved by changing the engineering specification materials and methods with low sustainability performance would be removed and options with better sustainability performance entered.

Table 3

Table 3 Common components of narratives from within the WaSC Asset Delivery Unit

➢ Common components of narratives			
Alignment with properties of the WaSC	Alignment with chronological events	Financial constraints and drivers	Impact on service provision
➢ Leadership ➢ Vision; Mission Policies; Strategy ➢ Roles and responsibilities ➢ Resources knowledge & skills	➢ Restructuring events ➢ Contracts	➢ Cost savers ➢ Profit generation ➢ Cost increase ➢ Profit loss ➢ Available finance ➢ Penalty avoidance	➢ Risk impact ➢ Service impact

Fig 3

Water Utility Adoption Model (wUAM)

Organisation innovation adoption was influenced by:

Evaluative Domains

Alignment with the properties of the WaSC	Alignment with chronological events	Financial constraints and drivers	Impact on service provision
➢ Leadership: (1,2,3,4) vision, mission, policies ➢ Strategies (9) ➢ Roles and responsibilities (5,12) ➢ Resources (6,10)	➢ Restructuring (13) ➢ Contracts (13)	➢ Cost saver (1) ➢ Profit generation (1) ➢ Cost increase (8) ➢ Profit loss (8)	➢ Service impact (11) ➢ Risk impact (7)

Domains

➢ Components of domains (Number shows how the component is employed in narratives

wUAM narratives

Innovation adoption traction was increased when:

1. The innovation was perceived to reduce cost or increase profit. (*r*)
2. Market forces exert a cost pressure on the WaSC that align with the sustainability benefits of the innovation. (*r*)
3. Regulatory framework incentives and penalties are aligned with the sustainability benefits of the innovation. (*r*)
4. Vision, mission and goals of the WaSC are aligned with the sustainability benefits of the innovation. (*r*)
5. Leadership with decision making authority is allied to the innovation. (*e*)
6. Resources were allocated to support the innovation development. (*e*)
7. Expert research was used to validate the performance of the innovation. (*e*)

Innovation adoption traction was reduced when:

8. The innovation was perceived to increase cost or reduce profit. (*r*)
9. The innovation conflicted with the strategies of the WaSC. (*r*)
10. The resources (knowledge, skills, operational, maintenance, financial etc) requirement of the innovation and the resources allocate/available to the WaSC was mismatched. (*r*)
11. Innovation targeted (Technical) assets critical to service delivery. (*r*)
12. Innovation broached entrenched roles and responsibilities. (*r*)

Innovation traction was influenced by:

13. The relationship of the timing of the innovation process to the WaSC's restructuring events and contracts. (*e*)

(e) =innovation process events, (r)=relationship between WaSC & innovation

Fig. 3. Water Utility Adoption Model: wUAM is a conceptual map summarising the domains that influenced organisation innovation adoption, the components of each domain, how they relate to the narratives employed.