# Where are we going? Using capabilities to study digital transformations of established organisations *(old title)*

# Who's smart in the smart city? Studying utilities' ability to digitally transform *(potential title?)*

**Abstract:** …

To the reader: these are parts of an earlier manuscript that I plan to re-work. Hence, this is not a complete manuscript but rather 'bits and pieces' of a potential manuscript. For the ScAIEM PhD Colloquium, I have two major points I would like to discuss and receive feedback on:

- Use of absorptive capacity: ACAP is an organisational construct that, in this paper, has been applied to discuss the 'general ability' of water utilities to implement and use digital technologies. Hence, I'm not interested in identifying the routines or processes of the individual organisations that (potentially) build absorptive capacity (as this likely differs between utilities and requires a different kind of study than the one I've done), but rather to investigate if they appear to have it on a general level. Do you think that application of the concept work? Do you have any suggestion on how I can make it stronger/different?
- Framing: in the revised version, I intend to frame it around the concept of the 'smart city'. Realising the vision of the smart city will depend on the ability of more 'untraditional' (in terms of digitalisation) organisations to digitally transform, which motivates studying the ability of a type of organisation such as water utility to implement and use these technologies. What do you think about such framing? (Following this framing, I'll have to update the background sections as they currently follow an earlier framing of the paper focusing more generally on the DT of established organisations.)

**Key words:** Digitalization, digital technologies, smart cities, water utilities, absorptive capacity

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## 1. Introduction

'The smart city' builds on the vision of using cutting-edge technology and data-driven solutions to improve the quality of life for citizens while optimizing the use of resources and infrastructure. The core idea behind smart cities is to leverage the power of technologies such as information technology, Internet of Things (IoT), and data analytics. Due to advancements in digital technologies, enabled by continued miniaturisation, improved data storage and processing capacity, and decreasing costs, the '*vision of ubiquitous computing become very close to reality*' (Legner et al., 2017, p.302). In the smart city, various aspects of urban life, such as transportation, energy management, public services, and communication, are integrated and optimized to enable a more efficient, sustainable, and connected environment. Hence, the vision of the smart city depends on the ability of a number of different actors to integrate digital technologies and, eventually, become digitally transformed.

Yet, several studies have shown how established organisation struggle to digitally transform (Ghosh et al., 2022; Loonam et al., 2018; Tabrizi et al., 2019). Despite the promise of digital technologies and visionary reports of a digitalised future, many established organisations are stuck in procedures of their current businesses and struggle to adjust when faced with this new environment. Studies dealing with

the digital transformation of organisations have risen significantly over time (Hanelt et al., 2021), where many have been concerned with providing guidance on various aspects of a digital transformation (Hess et al., 2020). For instance, prior studies have identified what constitutes digital dynamic capabilities (Warner and Wäger, 2019), suggested that managerial capabilities are the main driver of a digital transformation (Li et al., 2018), and emphasised the importance of organisational culture in managing a digital transformation (Sousa-Zomer et al., 2020). Yet, many of these studies depart from the business field, where digital transformation is depicted as a matter of future survival for firms (Sebastian et al., 2017).

In contrast, several key actors in the smart city are public entities that do not experience the same market pressures to digitalise. In addition, some of these organisations are examples of 'high reliability' organisations, where the reliability the organisations is considered vital given the critical societal service they provide (Weick, 1987). Hence, these organisations prioritise stability and reliability, over innovation and change (La Porte, 1996). This, in turn, may create a tension between the high-reliability organisation identity and the characteristics of a digital transformation (Poláková - Kersten et al., 2023). Ultimately, this leads to the questions - are these organisations ready to digitally transform?

Hence, the purpose of this study is to investigate the ability of utilities, actors that are central to realise the vision of the smart city, to digitally transform. The paper is based on a study of the implementation and usage of digital technologies within public water utilities, whom are responsible for providing water services such as potable water, drainage, and sewerage, to society. While previous studies have shown that water utilities often have limited ability to engage in innovation and change (cf. Kiparsky et al., 2016, 2013; Krozer et al., 2010), there is a strong ongoing professional discourse advocating for the necessities to digitalize under the label of 'digital water' (cf. Sarni et al., 2019). Theoretically, we draw upon the concept of absorptive capacity, which describes an organisation's ability '*to recognise the value of new, external information, assimilate it, and apply it*' (Cohen and Levinthal, 1990, p.128).

The paper is structured as follows…

## 2. Background

In the following section, we present what previous studies have said about the digital transformation of established organisations. First, we start by clarifying how we conceptualise digital transformation and related concepts. Thereafter, we present how previous studies have studied the (potential) digital transformation of organisations.

### The concepts of digitisation, digitalisation, and digital transformation

The number of publications dealing with digital transformations of organisations has risen significantly over time (Hanelt et al., 2021). However, despite increased attention and several efforts to clarify what 'digitalisation' and 'digital transformation' mean (cf. Gong and Ribiere, 2021; Vial, 2019), there is still no common understanding of what these terms imply. Instead, the terms are often used vaguely and interchangeably (Legner et al., 2017). Many scholars and practitioners still also struggle to grasp what a so called 'digital transformation' really is and whether or not it represents a new phenomenon (Wessel et al., 2021). While some scholars argue that digitalisation is part of the already established field of information systems and management (cf. Riedl et al., 2017), others mean that it should be viewed as an evolution of the IT-enabled transformation phenomenon (cf. Vial, 2019).

In this paper, we make the following conceptual distinctions between digitisation, digitalisation, and digital transformation. Digitisation describes the general process of converting analogue data into digital format (Tilson et al., 2010). While it is often applied to describe the enacting of this process (cf. Verhoef et al., 2021), we argue that is also about understanding, or envisioning, what can or cannot be digitised (and the possible implications of it). Digitalisation, on the other hand, describes the process of adopting and using digital technologies in individual, organisational, and societal contexts (Legner et al., 2017).

Hence, it implies that digital technologies are diffused and used but does not say anything about the impact they have on these contexts. In comparison, the concept of digital transformation is often used to describe that some kind of fundamental change has occurred through the adoption of digital technologies. By emphasising *fundamental*, it allows us to differentiate '*from other non-fundamental changes, such as digitization and digitalization*' (Gong and Ribiere, 2021,p.9). Hence, as defined by Vial (2019), a digital transformation is a '*process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication and connectivity technologies'* (p.118). In our case, we use digital transformation to describe a process of significant changes to an organisation through the adoption of digital technologies.

Furthermore, in line with Verhoef et al. (2021)[1], we find it useful to describe the digital transformation of an organisation into three sequential phases; digitisation, digitalisation, and, finally, digital transformation. It is not until the organisation has reached the final phase that we actually can talk about a *transformation* (i.e. fundamental change) of the organisation. The two former (more incremental) phases are necessary to reach the more pervasive phase in the end (Loebbecke and Picot, 2015; Matt et al., 2015; Parviainen et al., 2017). However, in contrast to Verhoef et al. (2021), we divide the final phase, digital transformation, into two different kinds. As shown by other studies, the outcome of a digital transformation process can have different impacts on the organisation (Hanelt et al., 2021; Berman and Marshall, 2014). Consequently, in line with previous studies (cf. Gong and Ribiere, 2021; Wessel et al., 2021), we make a distinction between a transformation that sustains and enhances existing value propositions of an organization, and a transformation that disrupts the existing business and results in new value propositions. Since both represent a digital transformation, but of different type and scope, we hereafter refer to them as a *reinforcing* versus a *reconfiguring* digital transformation.

### Digital transformations of organisations

Visionary scholars have state that everything that can be digitised and automated, will eventually be digitised and automated (Brynjolfsson and McAfee, 2014). Thus, as argued by Hess et al. (2020), '*no sector or organization is immune to the effects of digital transformation'* (p.2). Within some industries, such as music, media, or retailing, we have already witnessed how digital technologies have had a significant impact (cf. Karimi and Walter, 2015; Willems et al., 2017). With the entrance of new digital competitors, changing customers' demands, and disruptive core technologies (Verhoef et al., 2021; Vial, 2019; Warner and Wäger, 2019), many incumbent organisations suddenly find themselves facing a new reality. While new entrants that are 'born digital' have grown into powerful players, many traditional actors find their value proposition under threat (Sebastian et al., 2017).

Hence, a digital transformation of organisations is not only about the usage of new (digital) technologies, but also about changes in business models, structures, and organisational processes (Hess et al., 2016). For instance, new types of competencies or roles, such as 'algorithmic brokers', can emerge (Waardenburg et al., 2022) and it can enable organisations to break away from path-dependencies and lock-ins (Bohnsack et al., 2021). However, research has shown that despite the expected potential of digital technologies, many are still at an early stage of their digital transformation process (Loonam et al., 2018; Sebastian et al., 2017) and struggle to adapt to the new technologies. The projected transformational effects are often yet to come in the future (Ghosh et al., 2022).

Incumbent organisations, successfully operating in (what previously were) stable environments often have limited absorptive capacity with respect to alternative technologies constituting a novel environment (Siachou et al., 2021; van Mossel et al., 2018). Hence, several studies have set out to investigate what established organisations need in order to undertake a digital transformation. The question has received substantial attention, partly due to the presumed 'digital imperative' (Gong and Ribiere, 2021; Fitzgerald et al., 2014), as well as a common fear of being left behind in the digital era (Ghosh et al., 2022; Siachou et al., 2021). As digital technologies have accelerated the speed of change,

[1] However, Verhoef et al. (2021) apply a slightly different definition of digitalisation than the one we apply in this paper.

it also causes increased environmental volatility, complexity, and uncertainty (Loonam et al., 2018; Matt et al., 2015).

Due to the disruptive nature of digital technologies, dynamic capabilities have been suggested as a proficient lens for studying digital transformation of incumbent organisations (cf. Ellström et al., 2021; Warner and Wäger, 2019). This does not only apply for the organisational level but also for specific processes (cf. Chirumalla, 2021), or for inter-organisational issues (cf. Helfat and Raubitschek, 2018; Kindermann et al., 2022). Based on a study of senior executives' experiences of digitalisation projects, Warner and Wäger (2019) identified nine micro-foundations that are important for developing dynamic capabilities for a digital transformation, which includes, among others, digital scouting, strategic agility, and navigating innovation ecosystems. They argue that the ubiquity of digital technologies has changed both the nature and purpose of dynamic capabilities. In another study, Sousa-Zomer et al. (2020) investigated the antecedents for digital transformation capabilities and identified three micro-foundations related to organisational culture; digital savvy skills, digital intensity, and conditions for action and interactions. When combined, these micro-foundations form a digital transforming capability. In a similar matter, Carcary et al. (2016) suggested core capabilities, related to the organisational culture, that are important for a digital transformation. Another study by Li et al. (2018) investigated how SMEs with inadequate capability and resources can drive digital transformation. They showed that they do it through managerial cognition renewal and social capital development, as well as team building and organisational capability building.

Hence, in line with previous studies, we apply organisational capabilities as a lens to study the (potential) digital transformation of organisations. In the following section, we present capabilities and the theoretical framing of this paper more in-depth.

## 3. Theoretical framework

As discussed in the previous section, a number of studies have investigated what organisational capabilities can enable a digital transformation. In this section, we first return to the concepts of organisational capabilities and capacities more generally, and, thereafter, move on to absorptive capacity specifically.

### Organisational capabilities and capacities

In research, 'ordinary capabilities' describe how an organisation 'makes a living' through its daily operations (Helfat and Winter, 2011). Thus, they are ordinary in the sense that they help the organisation to successfully remain at their status quo (ibid). However, while central to daily operations, heavy investments in the current ordinary capabilities can make an organisation vulnerable to environmental change. Several studies have shown how previously successful companies, such as Kodak (Lucas and Goh, 2009), have failed to adapt when facing technology shifts, demonstrating how their core capabilities turned into core rigidities (Leonard-Barton, 1992) creating essential organisational inertia.

To describe how and why some organisations succeed, while others fail, to adjust to these changes, Teece et al. (1997) introduced the concept of dynamic capabilities to analyse the sources of wealth creation and capture by organisations. The term 'dynamic' refers to the capacity to renew competencies to achieve congruence with the changing business environment, while the term 'capabilities' emphasises the key role of strategic management to meet the new requirements. Hence, dynamic capabilities are distinguishable from an organisation's ordinary capabilities and are often associated with the innovative activities of an organisation (Helfat and Winter, 2011; Teece, 2014; Zahra et al., 2006). As described by Teece and Leih (2016, p.7) '*ordinary capabilities are about doing things right, dynamic capabilities are about doing the right things*'. Dynamic capabilities, however, are context dependent. What may be an ordinary capability of one organisation, may constitute a dynamic capability of an organisation in another context (Zahra et al., 2006). In addition, previous studies have suggested that ordinary

capabilities also can evolve and contribute to organisational responses to changing environments (Schriber and Löwstedt, 2020).

A related, and sometimes overlapping, concept is absorptive capacity. Just like dynamic capabilities, absorptive capacity is related to the general innovation ability of the organisation and needs to be sustained over time (Cohen and Levinthal, 1990). Absorptive capacity can be seen as a kind of dynamic capability (Jansen et al., 2005; Zahra and George, 2002). Even if the term was coined earlier (cf. Kedia and Bhagat, 1988), Cohen and Levinthal's paper from 1990 is generally accepted as the seminal paper establishing the concept of 'absorptive capacity'. According to Cohen and Levinthal (1990), absorptive capacity refers to an organisation's ability to '*recognize the value of new, external information, assimilate it, and apply it to commercial ends*' (p. 128). They suggest that it largely is a function of an organisation's prior related knowledge, which makes it a history- and path-dependent construct. Among others, absorptive capacity has been applied to indicate firms' receptivity to technological change (cf. Kedia and Bhagat, 1988), as well as study their ability to use outside knowledge (cf. Koza and Lewin, 1998).

### Potential and realised absorptive capacity

Almost a decade after the initial concept was introduced, Zahra and George (2002) presented a re-conceptualisation and expansion of the initial concept. In their model, absorptive capacity is conceptualised as a dynamic capability, which allowed them to distinguish four dimensions of absorptive capacity. Zahra and George (2002) argued that absorptive capacity can be divided into four interrelated, but distinct, capabilities; acquisition, assimilation, transformation, and exploitation, where the two former constitutes an organisation's *potential* absorptive capacity, and the two latter the *realised* absorptive capacity.

The first capability, *acquisition*, refers to an organisation's ability to identify and acquire externally generated knowledge that can be of importance for its operations. The efforts into acquiring this knowledge have three attributes; speed, intensity, and direction, which influence the overall absorptive capacity. The second capability, *assimilation*, refers to an organisation's routines and processes that allow it to analyse, understand, and interpret the newly acquired information. New ideas may be overlooked if the organisation struggle to comprehend them, for instance, if it depends on complementary assets that are not available at the recipient organisation.

The third capability, *transformation*, refers to an organisation's ability to develop and refine routines that allow it to combine its existing knowledge with the newly acquired and assimilated knowledge. This may require adding or removing knowledge, or interpreting existing knowledge in a new manner. Finally, the fourth capability, *exploitation*, refers to an organisation's ability to refine, extend, and leverage from its existing competencies or incorporate new knowledge into its operation. While an organisation may leverage from new knowledge serendipitously, the presence of structure and routines allows it to sustain the exploitation of knowledge over time.

Hence, acquisition, assimilation, transformation, and exploitation play different, but complementary roles in building absorptive capacity. For instance, an organisation usually must acquire knowledge before exploiting it. Similarly, an organisation can acquire new knowledge but fail to transform and exploit it. Hence, these subsets of absorptive capacity co-exist, but are insufficient on their own to improve an organisation's performance.

Zahra and George (2002) is today one of the most cited[2] papers on absorptive capacity and have received both praise and criticism. For instance, Todorova and Durisin (2007) argue that Zahra and George fail to sufficiently build on prior work and, in turn, suggest their own refinement of the model. In this paper, however, we stay with the original model as presented by Zahra and George (2002).

[2] In a search on Web of Science in May 2023, the paper by Zahra and George (2002) was the second most cited paper after Cohen and Levinthal (1990).

# 4. Methodology

## 4.1 Research design and context

This paper is based on a qualitative study of digitalisation within the water sector. As the digital transformation of organisations still is unfolding, a qualitative approach is suitable to untangle this process (Denzin and Lincoln, 2000). The water sector is generally considered to be in the early stages of digitalisation (Sirkiä et al., 2017; Calvino et al., 2018, p.28), however, there is a growing professional discourse in the sector on 'digital water' and the potential advantages of a digital transformation of water utilities (Sarni et al., 2019; Ziemer and Clausnitzer, 2017). In this study, we primarily focused on water utilities, who have a key role in the water sector (Kiparsky et al., 2016; Lieberherr and Truffer, 2015; Smith et al., 2005).

We conducted the study within a Swedish context. In Sweden, the responsibility to provide water services, such as potable water, sewerage, and drainage, falls on the municipalities. Hence, Swedish water utilities operate as non-profit organisations that only can charge the necessary costs of providing these services. Their exact organisational form can vary (e.g., part of a municipal division or delegated to an incorporated company owned by the municipally), but all Swedish utilities operate by law under the governance of a public monopoly. Sweden consists of 290 municipalities of various sizes, both geographically and population wise. For instance, the municipality of Jokkmokk in the very North of Sweden has one of the smallest populations, while simultaneously being one of the largest municipalities geographically.

On the one hand, it is possible to argue for the similarity of these organisations. Water utilities have the same fundamental mission and responsibilities and follow the same rules and legislation. At the same time, they vary greatly in organisational size and organisational forms. Hence, we acknowledge that these are different organisations and it is not possible to argue that these organisations (as a whole) possess absorptive capacity with regard to digitalisation or not. Yet, we believe it is useful to apply for a general discussion of the utilities' ability to implement and use digital technologies, and its potential implications for these organisations.

## 4.2 Data collection

We conducted our data collection from March 2021 until September 2022. The study primarily builds on semi-structured interviews with representatives of various roles from different organisations within the water sector. As the role and representation of the respondents differed, the format and focus of the interviews varied depending on the respondent. To clarify this, we have categorised the respondents into five broad categories; developers, users, strategists working at the utilities, industry representatives of the sector as such, and suppliers of equipment and services to the utilities, each explained in further detail below. The representatives from utilities all come from medium to large sized utilities. In addition to the interviews, we did several informal calls to representatives of the sector, which were important to orientate ourselves and identify key persons to contact.

The initial four interviews focused on the development of AI-models at water utilities. Hence, we have categorised these respondents as 'developers', even though none of them were software developers in the traditional sense. Our starting point was an artificial neural network (ANN) model for evaluating the condition of water pipes. The model was developed at one of the larger water utilities in Sweden and had received attention among other utilities through forums such as the industry association Swedish Water (in Swedish: Svenskt Vatten) and professional magazines. We started by reaching out to representatives at this utility, which thereafter helped us get in touch with another water utility that had developed a similar model. At each utility, we interviewed two representatives. In both cases, we were in direct contact with the person who had done the actual coding and development of the model, as well as another (more senior) employee that supported the project. In these interviews, we mainly focused on the utilities' ability to develop such models in-house, as well as the advantages and disadvantages of doing such.

Our second interview category is 'users', which in this case refers to users of applications such as the previously mentioned AI-models. Both of the previously mentioned utilities were involved in an industry-wide collaboration where their AI-models had been tested and validated. Through this collaboration, we got in contact with six other utilities that all had, to various degrees, worked with AI-applications (both these specific AI-models, as well as others). These utilities represented organisations of various sizes (medium to large) and geographically located in different parts of Sweden. In addition, the respondents had different roles and responsibilities at their utilities. In these interviews, we mainly focused on what the utilities need in order to implement and use such applications.

The third category is strategists, which in this case refers to two digitalisation strategists. Through our initial interviews, we got in contact with employees that worked more strategically with digitalisation at their utilities. At one of the utilities, the respondent had the explicit role of a 'digitalisation strategist', while the other respondent was an IT-manager who was involved in strategic planning. Compared to previous interviews, these interviews focused more broadly on digitalisation and what utilities need in order to advance their digitalisation efforts.

While our primary focus was water utilities, our final two categories represent other types of actors within the sector. First, we interviewed two representatives from two water industry associations in Sweden. The first representative, from the utilities' industry association Swedish Water (in Swedish: Svenskt Vatten), was chosen as they had been involved in digitalisation activities within the sector. The second representative, from the association The Water Industry (in Swedish: Vattenindustrin) which assembles suppliers and consultants to the utilities, was chosen due to their central role in the association.

Lastly, we conducted three additional interviews with representatives from one supplier of a digital platform for smart water management. The platform includes different software for the complete commercial cycle of a water utility. We chose to focus on this specific supplier because two of the utilities represented in this study had worked with this specific supplier. All the respondents, and their respective roles and organisations, are summarised in Table 1.

Table 1. Summary of interviews.

| Interview | Respondents | Respondent category |
|---|---|---|
| Interview 1 (online) | Respondent 1 | Developer (utility) |
| Interview 2 (online) | Respondent 2 | Developer (utility) |
| Interview 3 (online) | Respondent 3 | Developer (utility) |
| Interview 4 (online) | Respondent 4 | Developer (utility) |
| Interview 5 (in person) | Respondent 2 | Developer (utility) |
| Interview 6 (online) | Respondent 5 | User (utility) |
| Interview 7 (online) | Respondent 6<br>Respondent 7 | User (utility) |
| Interview 8 (online) | Respondent 8 | User (utility) |
| Interview 9 (online) | Respondent 9<br>Respondent 10<br>Respondent 11 | User (utility) |
| Interview 10 (online) | Respondent 12 | User (utility) |
| Interview 11 (online) | Respondent 13 | User (utility) |
| Interview 12 (in person) | Respondent 14 | User (utility) |
| Interview 13 (online) | Respondent 15 | Strategist (utility) |
| Interview 14 (online) | Respondent 16 | Strategist (utility) |
| Interview 15 (online) | Respondent 17 | Industry association (external) |
| Interview 16 (online) | Respondent 18 | Industry association (external) |
| Interview 17 (online) | Respondent 19 | Supplier (external) |
| Interview 18 (online) | Respondent 20 | Supplier (external) |
| Interview 19 (online) | Respondent 21 | Supplier (external) |

In addition to the interviews, one of the authors also participated in two industry conferences. One of the conferences was a national water conference, organised by the industry association Swedish Water, which took place 18th-19th January 2022 digitally. The other conference was an international water conference, organised by the International Water Association, which took place 11th-15th September 2022 in Copenhagen, Denmark. Finally, we complemented our data collection with secondary data sources, such as public reports and websites.

### 4.3 Data analysis

To analyse our empirical data, we applied the concept of absorptive capacity divided into four, interrelated capabilities. Hence, we were interested in *if* the utilities appeared to have acquired, assimilated, transformed, and/or exploited the information related to digitalisation, rather than identifying the exact routines and processes that constituted these capabilities.

As we iterated between empirics and theory, we read and compared our interpretation to how others had empirically applied absorptive capacity. Absorptive capacity has previously been shown to be a useful framework to understand the use and management of information technologies (cf. Boynton et al., 1994). However, previous studies have used a variety of different research methods (such as case studies or archival data) and studied it in different empirical settings, with different contexts and units of analysis (Volberda et al., 2010). Hence, we acknowledge that the four dimensions presented by Zahra and George (2002) can be interpreted in various ways when applied empirically. Our main point of reference was the original paper by Zahra and George, but we compared it to other papers that had used the four dimensions of absorptive capacity (cf. Jansen et al., 2005). Consequently, we explicate our specific interpretations of the dimensions and their applications to our empirical data in Table 2.

Table 2. Empirical interpretation of absorptive capacity.

| Definition by Zahra and George | Our empirical application |
|---|---|
| *Acquisition* refers to the organisation's ability to identify and acquire externally generated knowledge. | Are there any indications that the utilities are aware of the development of digital technologies and the general digitalisation trend? |
| *Assimilation* refers to the organisation's ability to analyse, understand and interpret the externally acquired knowledge. | Are there any indications that the utilities have analysed, understood, and interpreted what digital technologies can imply for them? |
| *Transformation* refers to the organisation's ability to develop and refine routines that allow them to combine existing and newly acquired knowledge. | Are there any indications that the utilities have started to develop or refined their processes, routines or resources to facilitate the usage of digital technologies? |
| *Exploitation* refers to organisation's ability to incorporate the acquired knowledge into their operation. | Are there any indications that the utilities have widely started to use and leverage of digital technologies in their daily operations? |

We performed the data analysis in the software MAXQDA, where we both transcribed and coded the interviews. In the beginning, we used an open coding process to capture different aspects (e.g. drivers and barriers) related to the utilities' ability to adopt digital technologies. Thereafter, we started to thematically group and categorise the codes according to the four main dimensions presented by Zahra and George (2002). One of the authors performed the coding and, thereafter, presented it to the other author for further refinements.

## 5. Findings

### 5.1 Acquisition

Acquisition refers, according to Zahra and George (2002), to an organisation's ability to identify and acquire externally generated knowledge.

Several of the respondents noted that digital technologies represent a general technology trend in society. Not only does it influence them in their personal lives, such as in the way they manage their banking business or meet potential partners on dating apps, but they also recognised how digital technologies diffuse across other sectors. In one of the interviews, two of the respondents explained that they look beyond the water sector, for instance at energy utilities, for inspiration when it comes to the use of digital technologies. Another respondent noted:

> 'If you can use AI to drive a Tesla on autopilot or to identify cancer, we should also be able to find use for this technology as well.' – Respondent 10

In addition, they witness how water utilities abroad incorporate digital technologies in their operation. Several utilities, especially the larger ones, engage in business intelligence and participate in international contexts such as conferences and professional networks. As the respondents noted, they have noticed a growing interest in the use of digital technologies within the sector, from both utilities and other actors such as consultants and commercial actors. At a big, international water conference in autumn 2022, 'digital water' was one of the main themes at the conference. One of the participants at the conference noted that the company exhibition has gone from mainly representing traditional water companies, producing products such as pumps and pipes, towards including an increasing number of software companies, selling products such as digital platforms and analytical tools.

In Sweden, however, the respondents emphasised that most utilities are still early in their process to implement new digital tools. Compared to other countries, Sweden has abundant water resources and the utilities have not been forced to innovate their operations to gain efficiency. Consequently, as one of the respondents noted, there are few incentives for the utilities to rethink their operation:

> 'We should have done much more, but I guess it is because we have rich water resources and stable ground to build on. We have not been forced to digitise the same way as other countries. Because it is often crises that make us rethink our operations, where digital technologies can be part of the solution.' – Respondent 14

In addition, the respondents explained that the sector displays a general inertia. It does not only apply to the utilities but other traditional actors, such as suppliers, as well. The provision of water services has remained the same over the years, partly because no one has questioned how it is done. One of the respondents noted:

> 'The operation has not changed much from the 1950s until today, and we expect it to remain the same in the coming 30, 40, and 50 years ahead. No one has been interested or bothered to question it as long as it works.' – Respondent 18

Nevertheless, the respondents explained that they still expect digital technologies to become an integrated part of their operations as well. As the respondents noted, comparing themselves to others (within and outside their sector) gives them an idea about the direction they are heading. One of the respondents explained:

> 'The answer is already out there, we just have to look. Because there is an answer and that is where we are heading.' – Respondent 7

Hence, the utilities appear to be aware of the general (digital) technology trend in society and, while perceiving that they are 'slow on the ball' (Respondent 11), they still expect the use of digital technologies to increase within their context.

### 5.2 Assimilation

Assimilation refers, according to Zahra and George (2002), to an organisation's routines and processes that allow it to analyse, process, interpret, and understand information from external sources. In comparison to acquisition, and how the utilities acquire the information to start with, assimilation refers to how the utilities translate it to their context.

One of the main motivations for using digital technologies, mentioned by a number of respondents, was to enable new, more efficient, ways of working. When it comes to water services, the main product and services, i.e. water itself, cannot be digitised:

> 'It is not rocket science, we need water in our pipes. /…/ And you cannot access water in another way, there is no such thing as "wireless" water.' – Respondent 16

Instead, the respondents argued that digital technologies can be used as tools for, among others, data-driven decision-making. For instance, maintenance and renewal of the piped water system often rely on individuals' tacit knowledge and expertise about the systems. Due to their hidden nature underground, and sometimes insufficient information basis, it is difficult to make objective assessments of the systems. One of the respondents explained:

> 'In my opinion, this [digital tool] is a great example of how we go from very simple methods for deciding what pipes to renew, towards using a more data-driven approach.' – Respondent 13

By implementing such tools, the utilities may not only save time, but also reduce costs. Another respondent explained that better decisions, in turn, help them to decrease the overall maintenance costs:

> 'I believe our renewal planning can become much more efficient owing to this, i.e. findings and replacing the right pipes at the right time. Because that is the trick, if you get the renewal rolling the overall maintenance costs will decrease.' – Respondent 1

Historically, the utilities have relied on their suppliers for new technical solutions. However, digital technologies, which combine hardware and software, may pose new demands on both users and suppliers. At one of the utilities, they had installed antennas to get coverage to all their equipment. As one of the respondents explained, it basically put them on the border to become a telecom operator:

> 'We could develop a business model based on this. We could sell this service and really work on developing this idea. But we are not allowed to do it because we are a water utility.' – Respondent 15

At two other utilities, some of the respondents (Respondent 1-4) had been involved in developing AI-models for decision support. In both cases, it started as a project to test the suitability of such applications. In one of the cases, the project had a promising outcome and continued after its initial phase. When we returned to one of these respondents about a year after our initial interview, they were still developing AI-models for the utility and were now building a platform for these models. In the other case, the respondents were not as confident about the outcome and had trouble finding time for this project once the initial project finished:

> 'In the beginning, I had a four-month project employment when I focused solely on AI-applications. Since then, I have had significantly less time for this. That is often how it is, when you work as a project engineer you do not have time for additional tasks. Keeping track of the piped systems is enough as it is.' – Respondent 3

These respondents noted that it, on the one hand, becomes easier and easier to develop these kinds of analytical tools. Thanks to the development of software, it is fairly simple to develop and implement such applications without prior knowledge. On the other hand, as one of the respondents noted, it also entails a risk:

> 'I also believe it is a bit risky that it is so easy to develop such models, that even I, without prior knowledge in statistics or machine learning, can develop such models. Because I am probably making a lot of mistakes that a person who actually knows this easily avoids.' – Respondent 3

These two examples (telecom and AI) illustrate how the utilities went beyond their core business to enable the use of new digital technologies. However, as emphasised by several of the respondents, the question is if they should. One of the respondents argued that they must be allowed to remain a *water* utility in essence. For instance, in comparison to commercial actors, the utilities cannot regain development costs through profits or enter new markets to attract additional customers. Hence, using internal resources to develop digital hardware or software may be careless use of their resources. One of the respondents explained:

> 'Even though it is possible, the question is if we should. To develop an AI-model may not be that difficult but to say "this is the best model" is.' – Respondent 5

Instead, several of the respondents explained that they believe that they will depend on combined efforts with external actors. The utilities can develop and employ simpler tools themselves, but must rely on external actors for more advanced applications. Most respondents expected that their suppliers, such as database providers, will integrate more advanced functions (such as AI) in their software. As one of the respondents argued, they want easy plug-in solutions, since they neither have the 'time, energy, or resources' to do this themselves (Respondent 6).

To summarise, the respondents expect that digital technologies can provide benefits for their operations. In addition, they appear to have an idea of the needed efforts to increase the use of digital technologies on a general level, where external actors, such as consultants and suppliers, are crucial.

### 5.3 Transformation

In the framework of Zahra and George (2002), transformation denotes the organisation's ability to develop and refine the routine that facilitates combining existing knowledge with the newly acquired and assimilated knowledge.

According to our respondents, most utilities already have access to data. Even though the format and quality differ between utilities, most of them have gathered data related to the daily operation for years (such as reported leakages). However, it is often used in a limited matter. One of the respondents explained that the utilities must go from being data hoarders to becoming data users:

> 'We only use a small percentage of all the information we gather. We have access to all this data, but we do not put it to use.' - Respondent 15

Hence, the respondents emphasised that they first need to map and process the data they already have. The utilities have gathered data for different purposes at different parts of the organisation, but they often lack an overview of all this information. As one of the respondents explained, mapping the data is central to avoid multiple systems with the same purposes or functions. Furthermore, they have to process the data to assess its quality and accuracy. While some data is registered automatically (e.g. information from flow- or pressure sensors), others rely on manual inputs and can thereby differ in degree of detail and accuracy. As some of the respondents explained, some utilities have started to work with their overall data structure to obtain a better overview:

> ‘We try to gather all our data in one big data warehouse now. By that, we can combine data from different sources and put it to use more efficiently. This has been a big project for us.’ – Respondent 15

However, while the utilities have gathered and used data for years, the respondents anticipated that the increasing amount of data and possibilities to do more advanced analysis are going to put new demands on the utilities. For instance, the utilities may need to acquire new types of competencies, such as data engineers and scientists, which they traditionally have not possessed. However, as emphasised by the respondents, they have to compete with a wide range of industries over these competencies, where the utilities have trouble competing with regard to salary and status. Hence, it also requires that they educate civil engineers with new types of competencies. One of the respondents compared it to geographical information systems (GIS) knowledge, which previously was unusual expertise but now is common at most utilities. Several of the respondents emphasised that the utilities need to move away from traditional ways and start employing people with other types of backgrounds. One respondent explained:

> ‘Competence related to data integration and programming has, historically, been rare at water utilities. But things are starting to happen now. We have initiated efforts to employ data scientists that can work with our data. And I believe we will see more of this in the time to come.’ – Respondent 14

In addition, the utilities may need to enhance already existing types of competencies. One important aspect relates to cybersecurity. As providers of a critical societal service, security aspects are already an integrated part of their operations. However, it has previously mainly focused on physical assets. As emphasised by the respondents, digital technologies will pose new kinds of security threats. One respondent explained:

> ‘We have friends in our industry that already have been affected by this. In the U.S., there was a case when they increased the amount of chemicals in the water.[3] There is an imminent threat that requires us to secure the infrastructure around digitalisation. We have to increase our focus on this.’ – Respondent 16

Other competencies relate to procurements. As one of the respondents from an industry association pointed out, it is important that the utilities, to start with, request digital solutions when they procure. In addition, the utilities need to be knowledgeable enough to set reasonable requirements when they make the procurements:

> ‘If you want to buy a new computer for programming or gaming or other purposes, you have to know what specifics you are after. Otherwise, you will go to the closest retailer and there is a risk that they fool you. We need to become much better at this.’ - Respondent 15

Finally, the respondents emphasised the importance of experimentation. For instance, it helps the utilities to set the direction ahead. As some of the respondents mentioned, it is not obvious where to start or what to do with digital technologies. Furthermore, it helps them to evaluate the usefulness of these technologies. Several of the respondents mentioned that they work with ‘proof-of-concepts’ to test new applications on a small scale before they, possibly, roll it out on a larger scale. If it does not have any operational benefits, it will not work:

[3] In February 2021, hackers remotely accessed a water treatment plant in Florida, the U.S. For more information, see e.g. Marquardt et al. (2021) and Robles and Perlroth (2021).

> ‘There has to be an operational benefit in everything we do. /…/ If you want to succeed with the implementation of these technologies and the changes it implies, it has to make things better in one way or another.’ – Respondent 16

To summarise, the respondents emphasised that they need to intensify their work with data and, especially, how they put it to use. This, in turn, may require new competencies they previously did not possess as well as enhancing already existing ones. Lastly, experimentation helps them to test and evaluate the usefulness of these technologies.

### 5.4 Exploitation

Finally, Zahra and George (2002) use exploitation to refer to routines that allow firms to refine, extend, and leverage existing or create new competencies by incorporating acquired and transformed knowledge into their operations.

The respondents mentioned several examples of how to employ digital technologies in their operations. For instance, they explained how AI can be used to predict the capacity demand based on historical water usage data or to identify damages to wastewater pipes by studying images from TV-inspections. However, it was clear that most of these applications still were visionary and yet for the utilities to incorporate in their daily operation. As indicated by the respondents, it does not matter that all the other pieces, such as time and resources, are in place if the rest of the organisation is not on board. According to the respondents, a central aspect of this is leadership. Many digitalisation projects are driven bottom-up by engaged employees. However, for the organisation to seriously take on a digital transformation, the leadership must be committed. One respondent explained:

> ‘Leadership is very important in every organisation. Both to have a management group and middle managers that are willing to undertake this journey of change; that is where the key but also difficulties lay. For most utilities, that is not in place today.’ – Respondent 14

Apart from the leadership, the respondents also highlighted the role of the employees in this process. As emphasised by the respondents, implementing digital technologies can enable new ways of working that break with long-standing traditions and routines within the organisation. One respondent, who was involved in developing the AI-model at one of the utilities, explained that even though the tool was in place and gave promising results, the maintenance organisation was not on board. Instead, the AI-model did not have any substantial impact since the intended users did not adjust their routines accordingly. The respondent explained:

> ‘We are not there with our maintenance organisation yet. They have received indications from the model on what areas to prioritise and have made simple investigations based on it. However, they need to do repeated and more careful investigations. We have now renewed our efforts and, in addition, bought new instruments for leak detection.’ - Respondent 1

A closely related aspect, mentioned by the respondents, is trust. In addition to understanding why, and how, they can use these technologies they also must be able to trust their accuracy. As emphasised by the respondents, this especially concerns applications based on technologies such as AI or machine learning, where the employees cannot deduce how the applications reached their conclusions. Instead, they must test these applications so they slowly can build trust in these technologies. As explained by one respondent:

> ‘As long as you start testing it, and build trust in its arguments, then it will begin to roll. But it all depends on you starting to use it and build trust in it.’ – Respondent 8

Finally, one aspect of building this trust is how to present and visualise such results. As one of the respondents from the software supplier explained these tools must make lives easier, not harder, for the utilities:

> 'We put a lot of emphasis on easy-to-use solutions; user-friendly, nice interfaces, etc. It is already difficult to use new technologies, so they need to make our lives easier, not complicate it.' – Respondent 20

Hence, even though the respondents have concrete ideas on where and how to use digital technologies, many utilities are not there yet. To go from individual projects to a more comprehensive use of digital technologies within the organisation, the respondents highlighted the importance of having the leadership and employees on board.

To summarise, we have investigated what representatives from the water sector perceive as necessary to leverage digital technologies and presented it in relation to the capabilities of acquisition, assimilation, transformation, and exploitation. In addition to the quotes presented in the running text, we have added additional example quotes in Table 3. While the utilities appear to have acquired and assimilated information related to digital technologies, they are yet to transform and exploit it. In the following section, we discuss what this implies for the possible digital transformation of these organisations.

Table 3. Examples quotes from interviews.

| Acquisition | Assimilation | Transformation | Exploitation |
|---|---|---|---|
| General trend | Motivation | Data | Willingness |
| There are not that many people that find it [AI] very cool anymore, it has become commonly accepted in society. At the same time, they do not question the use of it, most people see that it is a tool that works and something we will see more and more of. – Respondent 2<br><br>I sometimes think about the stock exchange, and how digital they have become. /…/ They are a kind of role model in my opinion. – Respondent 9<br><br>We have to glance more at other industries, how they have done this [digitalisation]. – Respondent 18<br><br>I do not think Sweden has come very far if you compare it to other countries in Europe, Denmark for instance. On the other hand, they have had challenges with the water which have forced them to work with new solutions. – Respondent 13 | The purpose is to become better at managing our operations, and create insights with data systems that can visualise and enable us to come to new realisations. – Respondent 16<br><br>Above all, it frees up time. We can quickly receive an objective basis for decisions. If we do this without these tools, it take a lot of time and people have different opinions. So with this [AI-tool] we can save time and receive an objective analysis quickly and smoothly, which leaves us with more time for other things. – Respondent 2<br><br>For me, digitalisation means both more efficient ways of working and better decision support. /…/ It provides tools that enable us to visualise and draw conclusions we would not be able to with Excel sheets. – Respondent 18 | Large utilities often have a lot of data as they started early, on the initiative of Swedish Water I think, to work with databases and store data digitally. But there are many smaller utilities that have not come very far, they still try to find and digitise paper format. – Respondent 2<br><br>We have a lot of data ourselves, we have all our control systems within the process where we measure everything. We have more than 30 000 different types of alarms. So we already have a lot of data. - Respondent 16<br><br>We gather a lot of information, but there is no quality review, analysis, or compilation of the data we gather. So it becomes very interesting with artificial intelligence, how we can use all the information we already have gathered. – Respondent 4 | If you have managers and a management group that are willing to renew and change, then you have a lot to win. You will never get everyone on board, that is impossible. But to have the support from the management group, that is key to keep on developing. – Respondent 14<br><br>This organisation was built when digital tools such as artificial intelligence did not exist, or it did not exist in this context. This is a large organisation, so it takes time, with established processes and routines. Some people are positive towards new technology, others probably have too much to do as it is, they do not have time for this right now. So we have to explain that, it always requires work to change routines and processes, it does not happen by itself, but in the end, it is worth it. – Respondent 2 |
| Expectations | Comprehension | Competencies | Trust |
| From standing still for a very long time, things are now moving and we start to use artificial intelligence, even though many still barely are digitalised. – Respondent 4<br><br>Are we not a very slow industry really? Are we last on the ball? Yes we are. When it comes to reading customer meters we still use pen and paper to a large extent. - Respondents 9 and 11<br><br>A significant driving force for water utilities is to have safe water supply and management of wastewater services. And digitalisation enables us to do more with the money we have at hand. – Respondent 15 | We need this complete product because we neither have the time, energy, or resources to develop this ourselves. We want this product where we can press 'on' and it will start running directly. – Respondent 6<br><br>We cannot forget what type of organisation we are. We are a public utility that is here for the citizens. We cannot have a large R&D unit financed by the collective, because everything that the collective is financing needs to go right back to the collective. – Respondent 16<br><br>In the future, I believe preconditions will be accessible in our tools. These kinds of applications be built into all our operating systems. – Respondent 11 | We have GIS-engineers that are really good with databases, but maybe not with how to use the data. And we civil engineers that do not know what data we have, but know how well it represents reality. But to work technically with, for instance, AI, that competence we do not have. – Respondent 4<br><br>It is difficult to make good procurements if you do not have the right competence. And that is why we have to improve our competence in IT, data management, etc. – Respondent 15 | It [AI-model] needs to be trustworthy enough. It is difficult to explain how it works as it is now. It gives you an answer, but what does it mean? But there is an interest. If you get an answer that is good enough, people will start using it. /…/ So in the end, it is the reliability of it that decides. – Respondent 5<br><br>While you work with structuring the data and preparing it for further processing and so on, you also have to work with visualisation it to the rest of the organisation, that is how you win them over. When the CEO and managers receive the right information in a nice dashboard every morning, then it will fall into place. Because this relates to a number of questions, it is all related to visualisation. That is how you get the rest of the organisation on board. - Respondent 7 |
| | | Experiment | |
| | | If you want to use this as a utility, you need to verify the benefits before you dare to advocate it. – Respondent 7<br><br>I think we need more positive examples that show that it works. /…/ We need to show that it works so it is not only people interested in technology that use this. – Respondent 3 | |

## 6. Discussion

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## 7. Conclusion

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