

CRANFIELD UNIVERSITY

EDUARDA GIFFONI

REAL-LIFE RESILIENCE IN INTERNATIONAL WATER UTILITIES

SCHOOL OF WATER, ENERGY AND ENVIRONMENT

PhD

Academic Year: 2018 - 2022

Supervisor: Dr Heather Smith

Associate Supervisor: Dr Simon Jude

September 2022

CRANFIELD UNIVERSITY

SCHOOL OF WATER, ENERGY AND ENVIRONMENT

PhD

Academic Year 2018 - 2022

EDUARDA GIFFONI

REAL-LIFE RESILIENCE IN INTERNATIONAL WATER UTILITIES

Supervisor: Dr Heather Smith

Associate Supervisor: Dr Simon Jude

September 2022

This thesis is submitted in partial fulfilment of the requirements for the degree of PhD

© Cranfield University 2022. All rights reserved. No part of this publication may be reproduced without the written permission of the copyright owner.

ABSTRACT

Resilience is a highly aspired capability for the water sector. Whilst the concept has been vastly utilised in technocentric and engineering objectives, few studies have investigated the human dimensions of resilience in the context of international water utilities. Specifically, little is known about how the organisational environment, organisational culture and engagement with water customers may contribute to the resilience of the water sector and the challenges and opportunities of building resilience capabilities in these domains.

As the central context for this research, water utilities provide critical socio-economic utility to society. Disruptions felt by water utilities can negatively impact multiple communities, regional prosperity, and national security. However, water utilities monopoly nature may insulate them from the new and evolving demands derived from the free market, thus delaying the organic development of adaptive and agile capabilities. In addition, given that the infrastructure of water utilities tends to be ‘locked-in’ to a fail-safe stance, this bleeds through the organisation’s norms and beliefs, thus further perpetuating previous paths and hindering experimentation and transformative change. This is problematic because water utilities are more sensitive to local shocks and stresses as they are bound to local catchments and providing services to local communities, as opposed to energy utilities that may source energy from a wide range of geographical locations. All these factors make water utilities an interesting population of research from the lenses of Organisational Resilience.

Therefore, this thesis aims to understand the current stance and context within international water utilities in relation adaptability and Organisational Resilience –

spanning the organisational environment, culture, and interactions with customers. This work seeks to critically evaluate how the organisational and human capabilities may be shaped to enhance water sector resilience and the challenges and opportunities of doing so. Through semi-structured interviews and an iterative survey with international water utilities this qualitative research captures perceptions from water managers on embedding Organisational Resilience properties.

This research provides several contributions to the current body of knowledge. Primarily, the findings empirically identified novel challenges utilities face - spanning the cognitive frame, behaviour of individuals, and the context of the organisational environment - which flagged some key developmental areas to establish an organisational setting conducive of resilience.

For instance, chapter 2 delves deep into the organisational environment in water utilities. and identifies a need to broaden the cognitive frame of utilities to account for flexible concepts for enhanced sense-making and proposes novel categories of organisational silos and a set of cultural attributes that contribute to organisational resilience.

Moreover, chapter 3 explores the contextual property of organisational resilience, based on external relationships, to examine how customers may influence the resilience of water utilities. Although it was recognised a role of customers as passive beneficiaries of resilience, positive roles were also identified, such as: facilitators of more targeted initiatives, contributors to higher tolerance levels and positive behaviour-change, and resilience advocates.

An additional contribution of this research is the creation of a framework of an organisational culture of organisational resilience for the water sector in chapter 4. A

novel set of cultural attributes that were validated as conducive to the Organisational Resilience of water utilities were appraised from relevant literature. Derived based on the perspectives of utility managers, the set of cultural attributes clarifies Organisational Resilience beliefs and values that should shape individuals' behaviour and the organisational environment. Thematic analysis identified an over-emphasis on standards and procedures that may hinder positive changes towards a culture of organisational resilience. In addition, addressing organisational barriers perceived as a pre-requisite to cultural changes, which may lead to inaction. However, the water sector's impetus for talent recruitment and staff retention translated as an appetite to foment deeper relational ties with personnel.

Finally, this study highlights a real need for transforming the beliefs, values, and behaviour in water utilities to implement and sustain efforts in the human and organisational dimensions that are conducive of Organisational Resilience. Such resilience transformation will entail efforts in the cognitive, behavioural, and contextual aspects within utilities to address current challenges and leverage identified opportunities.

Keywords:

Organisational resilience, organisational culture, water customers.

ACKNOWLEDGEMENTS

I will always be truly grateful to all the people that supported me throughout. Starting with Dr Heather Smith who believed in me and pulled me back on track and immensely improved me as a researcher with her robust intellectual supervision of my work, positiveness, and kindness. I wish to be as clever and confident as you when I grow up. Secondly, I am grateful to Dr Simon Jude for the encouragement, wisdom, and optimistic words. Special thanks to Prof. David Denyer for being opened to listen about the research and the insightful discussions. Sam Skears, I immensely appreciate the uplifting chats and for going above and beyond to help students - your work is underrated!

I would like to thank the Water Research Foundation, PAC group and Cranfield University for funding the research, as well as all the interviewees and survey participants for sharing very interesting perspectives on resilience.

From a personal perspective, I would have not been able to conduct this research without my husband, cats, friends, and family. I dedicate this thesis to my husband, Edward, who experienced with me the ups and downs of a PhD and was always there when I needed; as a shoulder to cry on or as a complete nerd to have lengthy resilience discussions with. I am extremely grateful to Maybe cat for keeping me grounded and constantly reminding that it does not matter what I do in life, I will always be a cat servant. Swanson, my other feline son, thanks for making me all gooey inside in these last few months. You are the extra motivation that I needed.

I want to thank all my lovely friends, who probably still do not understand what I was doing during this journey, but they were happy for me regardless. Some names that fondly

come to mind are Laura, Ana Cecilia, Abbey, Alex, Ben, Martina, Karolina, Ewelina, Esther, Ali, Juan, Kayu, Kenisha and Camila Rosa.

I also would not be here without the passive aggressive support from my lovely and spirited family in Brazil: Monica, Paula, Bé, Goretti, Severino, Cucca and Vivico. To my loud and loving mum, thank you for your words of wisdom: *'Stop whinging and get on with it!'*. After this, I hopefully will not have any excuses for not travelling to Brazil to visit you (I may find a new one very soon though). Finally, I would like to send a massive thanks to my UK family for all the cuddles, encouraging words, love, and cups of tea, especially Mommy Darling, Popsie, Custard, Emily Anderson, Stuart, Lord, Pinkstar, Caitlin, Eva, Nathan, Drew, Joseph, Emily and Zach. I strongly hope that you will not have to say: *'Have you not finished your uni/college/school thing yet?'* e v e r again (obviously once I hopefully pass my VIVA).

'Besides the noble art of getting things done, there is the noble art of leaving things undone. The wisdom of life consists in the elimination of non-essentials.' – Lin Yutang

DISSEMINATION OF RESEARCH FINDINGS

Publications:

Giffoni E, Jude S, Smith H & Pollard SJT (2022) Real-life resilience: exploring the organisational environment of international water utilities, *Utilities Policy*, 79, Article No. 101394. Dataset/s: 10.17862/cranfield.rd.14555271

Giffoni E, Jude S, Smith H & Pollard SJT (2020) Real-life enterprise resilience, *Advances in Water Research*, 30 (3). Retrieved from <https://www.advancesinwaterresearch.org/awr/20200709/MobilePagedArticle.action?articleId=1621835#>

TABLE OF CONTENTS

ABSTRACT	i
ACKNOWLEDGEMENTS.....	v
DISSEMINATION OF RESEARCH FINDINGS	vii
TABLE OF CONTENTS	ix
LIST OF FIGURES	xii
LIST OF TABLES.....	xiii
LIST OF ABBREVIATIONS	xiv
1 INTRODUCTION	15
1.1 Resilience in the water sector	16
1.2 Aim and objectives	19
1.3 Theoretical evolution of resilience	20
1.4 Conceptual Perspective: Organisational Resilience	24
1.4.1 Organisational culture, organisational resilience, and the water sector	28
1.4.2 OR and stakeholders.....	30
1.4.3 Water customers and resilience	31
1.5 Overall Methodological Approach:	34
1.6 Thesis Plan.....	42
2 Real-life resilience: exploring the organisational environment of international	
water utilities.	46
Abstract.....	46
2.1 Introduction	46
2.2 Methods	51
2.3 Results	57
2.3.1 Narrow understanding of resilience.....	59
2.3.2 Justifying and sustaining resilience	60
2.3.3 Constrained environment for innovation.....	60
2.3.4 Resilience and resources.....	61
2.3.5 Silos and conflicting priorities.....	62
2.3.6 Uncertainty on leadership buy-in	65
2.3.7 Organisational structures	65
2.3.8 Lack of understanding of how to embed a culture of organisational	66
resilience	66
2.4 Discussion.....	67
2.4.1 Clarifying resilience to practitioners	68
2.4.2 Embracing paradoxical thinking.....	69
2.4.3 Bridging silos.....	70
2.4.4 Attaining leadership support.....	72
2.4.5 Configuring organisational structures	73

2.4.6	Need to unpack a culture of organisational resilience	74
2.5	Limitations.....	76
2.6	Conclusions	76
3	How do international water utilities perceive the role of customers in building the resilience of water services?	80
	Abstract:.....	80
3.1	Introduction	80
3.1.1	Customer engagement and resilience	81
3.1.2	Exploring customers' roles in building resilience	83
3.2	Methods	85
3.3	Results	92
3.3.1	Effective infrastructure planning	93
3.3.2	Facilitate effective local resilience initiatives	99
3.3.3	Advancements to innovative solutions	101
3.3.4	Coping capabilities	102
3.3.5	Positive and responsive behaviour-change.....	103
3.3.6	Prevention and/or early alerting of disruption	105
3.3.7	Resilience advocacy	106
3.3.8	Passive beneficiaries of resilience	108
3.4	Discussion.....	109
3.4.1	Appetite for meaningful engagement	109
3.4.2	Resilience beyond the boundaries of water utilities	115
3.4.3	Bottom-up resilience.....	120
3.5	Limitations:.....	122
3.6	Conclusion.....	123
4	Uncovering the links between Organisational Culture and Organisational Resilience for the water sector: a framework validation.	126
	Abstract.....	126
4.1	Introduction	127
4.1.1	Organisational resilience and the water sector	128
4.1.2	Organisational culture for water sector resilience	129
4.1.3	Theoretical perspective of organisational culture.....	130
4.2	Methods	133
4.2.1	Surveys' design and participants	146
4.2.2	Analytical process.....	151
4.3	Results	154
4.3.1	Framework Survey: Round 1 – quantitative assessment.....	154
4.3.2	Framework survey – Round 2	155
4.3.3	Frequent and major concerns for framework refinement.	157
4.3.4	Validated organisational culture of OR framework	159
4.3.5	Cross-cutting themes	161
4.4	Discussion.....	163

4.4.1	Broadening perspectives on organisational culture	166
4.4.2	Anchoring an organisational culture of OR.....	170
4.4.3	Study Limitations	173
4.5	Conclusion:.....	174
4.5.1	Considerations - Delphi method.....	176
5	Conclusion.....	177
5.1	Summary of findings	178
5.1.1	Exploring the human dimensions of resilience within the water sector 178	
5.1.2	Transitioning to an organisational environment of OR.....	179
5.1.3	Collaborating with customers towards OR.....	182
5.1.4	Advancing understanding of an organisational culture of OR	184
5.2	Challenges and opportunities to embedding OR	187
5.2.1	Implication of challenges:	187
5.2.2	Implication of opportunities:	190
5.3	Implications for policy.....	192
5.4	Implications for the water sector:	194
5.5	Reflections on context	196
5.6	Methodology: final reflections and contributions	198
5.7	Future research.....	201
	References:	205
	APPENDICES	229
	Appendix A - Interview Protocol and Consent Form.....	229
	Appendix B - Interview Topic Guide	235
	Appendix C – Survey analytical process	242
	Appendix D - Organisational Resilience Culture Framework (Round 1)	243
	Appendix E - Organisational Resilience Culture Framework (Round 2).....	261
	Appendix F - E-mail shared with the participants requesting their assessment of the analysis of the 1st survey round.....	275
	Appendix G – Sample of quantitative results from the first survey round which was shared with participants.....	276
	Appendix H – Template sample of the qualitative analysis shared with participants	279
	Appendix I – E-mail sent to participants requiring their participation in round 2 ...	287
	Appendix J – Evidence table and mind map relating to themes from chapter 2.	288

LIST OF FIGURES

Figure 1-1: Illustration of a thematic mind map with the logical hierarchy of codes, sub-themes, and themes for the creation of meaning.....	39
Figure 1-2: Diagram illustrating the linkages between the aim, chapters, methods and objectives of this thesis.	45
Figure 3-1: Example of the thematic mind-map to evidence the hierarchical order of codes, sub-themes, and theme.....	92
Figure 4-1: Description of the modified Delphi validation process utilised in this study.....	146
Figure 4-2: Example of a survey question posed to participants.....	149
Figure 4-3: Example of the thematic mind-map to evidence the hierarchical order of codes, sub-themes, and themes.....	154
Figure 4-4: Quantitative results on the attributes suitability in supporting OR for the first round, illustrating that the attributes ‘inclusiveness’ and joyfulness’ did not meet the consensus criterion.....	155
Figure 4-5: Quantitative results on the attributes suitability in supporting OR for the second round which illustrates consensus.....	156
Figure 4-6: Participants’ nomination of the least and most important cultural attributes in support of OR.....	157
Figure 4-7: Current perceptions on how to shape the organisational culture towards OR in water utilities and the process in support of an organisational culture change in support OR, adapted from Schein & Schein (2017).....	168

LIST OF TABLES

Table 1-1: Different conceptualisations of OR.....	26
Table 1-2: Reflections on the trustworthiness (validity and reliability) of this thesis, which was based on the criteria from Bryman, (2012), Cypress, (2017) and Noble & Smith, (2015).....	41
Table 2-1: Analytical framework of organisational properties that support organisational resilience, adapted from Lengnick-Hall & Beck (2005) and Lengnick-Hall et al. (2011).....	50
Table 2-2: Characteristics of the participants in this study.	52
Table 2-3: Identified themes and the implications for building organisational resilience, based on the theoretical framework from Lengnick-Hall and Beck (2005) and Lengnick-Hall et al. (2011).....	57
Table 3-1: Evidence table illustrating the themes, sub-themes, participants' quotes, and the number of respondents whose transcript contains the respective sub-theme....	87
Table 3-2: Identified themes on the role of customers in the resilience of water services, their corresponding meaning and relevance to resilience.....	94
Table 4-1: Structural levels of organisational culture adapted from Schein & Schein (2017).....	132
Table 4-2: Organisational Culture of OR Framework and its resilience rationale through RAG.....	135
Table 4-3: Description of surveys' participants.....	149
Table 4-4: Modified cultural framework proposed and validated in the second survey round.....	160

LIST OF ABBREVIATIONS

CIS	Critical infrastructure systems
OR	Organisational resilience
HRO	High-reliability organisations
RAG	Resilience analysis grid
SUDS	Sustainable urban drainage systems

1 INTRODUCTION

Critical infrastructure systems (CIS) provide essential services that enable the development and well-being of society (Chester & Allenby, 2019). As a CIS, water utilities have the incumbency to provide ongoing clean water supply and wastewater treatment services to different populations. Threats derived from climate change, aging infrastructure and rapid population growth are some of the main factors that may jeopardise the continuous delivery of these services going forward (Chester & Allenby, 2019; Juan-García et al., 2017).

Water utilities also heavily rely on systems that underpin their functioning (natural environment, physical assets, and people) and are tightly coupled with other CIS (Rinaldi et al., 2001). As such, detrimental impacts to a specific system may ripple as significant disruptions to water utilities and society. These complex interdependencies amongst CIS (Rinaldi et al., 2001), as well as emerging technologies and globalisation (Australian Government, 2016), expose water utilities to wider uncertainty and a multitude of threats that may manifest internally and externally. These threats are even more complex and challenging to anticipate, therefore leading to an increased risk of disruption and failure (Rinaldi et al., 2001).

Detrimental events previously thought to only impact the immediate vicinity of a system are now borderless, thus generating repercussions globally (van der Vegt et al., 2015). In addition, due to a more interconnected world, these events have now more than ever attained wider uncertainty, scope, and reach. Such complexity and uncertainty complicate effective and timely prevention and management of detrimental events in the shape of shocks (which are acute and unpredictable) and stresses (slow-onset chronic issues), which may impair water utilities' ability to effectively sustain functionality.

Risk management alone, as a conventional effort to boost robustness and prevent the realisation of threats (also known as a fail-safe strategy), is now recognised as an incomplete approach to manage the growing uncertainty and complexity attached to disruptive events (Ahern, 2011; van der Vegt et al., 2015). This has been attributed to the inability of risk management to account for events that have never happened before and to effectively steer recovery in very low-probability, but high-impact disruptions (Linkov & Palma-Oliveira, 2017). Therefore, safe-to-fail capabilities that entail flexibility and adaptive capacity towards enhanced preparedness and reduced downtime in moments of failure are increasingly perceived as suitable approaches to complement traditional risk management (Ahern, 2011; Chester & Allenby, 2019). However, due to the static and often reactive nature of CIS there has been a dearth of progress on transformative changes to keep up with emerging threats through adaptiveness and flexibility advancements (Chester & Allenby, 2019).

Resilience has been lauded as a concept that promotes flexibility and adaptive capacity (Hamel & Valikangas, 2003; Sellberg et al., 2018) to provide a “soft-landing” to systems when disruptive events occur (Linkov & Palma-Oliveira, 2017). From a technical perspective, one of the main benefits of resilience in CIS is its ability to complement risk analysis and governance by reducing blind spots through additional redundancy, short and long-term adaptive measures, and a more comprehensive grasp of threats through the lenses of a systemic scale instead of individual parts in the physical boundaries of CIS (Linkov and Palma-Oliveira 2017).

1.1 Resilience in the water sector

In the water sector, resilience has become a prominent effort (Ofwat, 2017), as it is postulated to help systems to manage and thrive against uncertainties and the effects of contemporary

challenges and future unknowns (Folke, 2016; Sheffi & Rice, 2005). Higher expectations from regulators and stakeholders on the capacity of water utilities in sustaining water services in face of growing complexity (Chalker et al., 2018) has also reinforced resilience as a key priority. Therefore, resilience has become a crucial endeavour in the water sector (EUM, 2017; Ofwat, 2017), which is exemplified by recent governmental mandates for resilience advancements (HM Government, 2014; US Government, 2018). In response, water practitioners internationally have also showcased increased interest and buy-in to incorporate resilience principles in the management of water utilities (EUM, 2017; Smith, et al., 2019).

Conventional resilience initiatives in water utilities have been heavily influenced by linear and technocratic assumptions to manage specified-threats (Lawson et al., 2020), akin to engineering resilience postulated by Holling, (1996). The engineering paradigm in resilience research tends to focus on robustness, hardness of assets and the isolation of infrastructure systems from the external environment (Rodina, 2019b). Similarly, infrastructure resilience as posited by the Cabinet Office, (2011) also focuses on physical assets and with a more specified and isolated view of threats (Smith et al., 2019).

However, focusing just on the physical environment to build resilience contrasts with the complex setting utilities depend upon and are immersed in; composed of a web of interacting systems with overlapping boundaries such as the natural environment, physical assets, institutional and human domains (Amir & Kant, 2018; Naderpajouh et al., 2018).

Whilst technocratic and linear perspectives of resilience have, to a certain extent, succeeded in delivering continuous services in the past (Chester & Allenby, 2019), the complexity and unpredictability of recent and future events have emphasised the saliency of adaptiveness and flexibility to build capabilities that allow water utilities to also swiftly bounce-back and adjust

responses (Crick & Bentley, 2020). In addition, infrastructure failures are no longer being reduced to technical defects, but as the consequences of broader and complex interactions (van der Merwe et al., 2018) between social, physical and natural domains (Hollnagel & Fujita, 2013).

The traditional pursuit for resilience in water utilities, based on physical infrastructure through risk management and augmenting the robustness of infrastructure (Lawson et al., 2020), is not enough in preventing disruptions, as some have flagged how negligence of the role of human domains may have triggered or exacerbated failures to CIS (Hollnagel & Fujita, 2013; Naderpajouh et al., 2018). However, there is a dearth of resilience studies for the water sector that clarifies the potential contribution of organisational and social capabilities in building resilience and the challenges in optimising these in water utilities. Therefore, resilience scholars are increasingly emphasizing the importance of developing safe-to-fail strategies specifically through the development of social and organisational capabilities, as they are key providers of sentience to CIS and therefore resilience (Chester & Allenby, 2019; Hollnagel, 2014; van der Merwe et al., 2018).

In particular, the need to advance understanding of how resilience may be augmented through organisational dynamics, behaviour and culture (van der Merwe et al., 2018) and, internal and external social relationships and interactions (Akamani, 2016; Crick & Bentley, 2020) has been emphasised from academia, industry and governmental spheres (Lawson et al., 2020; Ofwat, 2017; Smith et al., 2019). Based on this, some studies have evinced some key characteristics in the human domains relevant to utilities that can support adaptive capacity, such as a learning environment (Mafabi et al., 2015) that embraces innovation and proactiveness (Farrelly & Brown, 2011), to deploy resources effectively (Crick & Bentley,

2020) with emphasis on organisational culture (Summerill et al., 2010) which is led by example by senior-managers (Baker et al., 2018).

Whilst there is growing recognition that resilience must be developed more widely to prevent short-sightedness and an isolated view of threats (Chester & Allenby, 2019; Smith et al., 2019; van der Merwe et al., 2018), there is a need to clarify the practicalities of doing so in the social and organisational realms and in the context of water utilities.

Although engineering and technocratic perspectives have underpinned the main strategies for resilience in water utilities (Crick & Bentley, 2020; Lawson et al., 2020; Rodina, 2019b), this thesis will follow a softer stance by focusing on the organisational and social capabilities. With the view to move beyond an over-emphasis in the built-environment when resilience is employed in water utilities, Organisational Resilience (OR) was chosen as the main overarching concept that underpins all sections across this research.

1.2 Aim and objectives

This research aims to investigate how the social and organisational domains may be adapted and developed towards OR in international water utilities.

The following objectives were utilised as the foundation for the selection of the research paradigm, analytical methods and to address the research aim.

Objective 1: To investigate from existing literature the OR challenges and opportunities relating to the water sector and identify knowledge gaps.

Objective 2: To capture the perceptions of water utilities' representatives regarding the current challenges and opportunities in developing organisational (internal) capabilities conducive to OR principles.

Objective 3: To capture the perceptions of water utilities' representatives regarding the current challenges and opportunities in developing social (external) capabilities conducive to OR principles.

Objective 4: To capture the perceptions of water utilities' representatives on organisational culture and advance understanding of what an organisational culture of OR looks like in the context of water utilities.

As this thesis follows a paper-based structure across all analytical chapters, the author acknowledges some degree of repetition. As such, each chapter may contain similar content specifically in the introduction and methods sections. The author has minimised the theory showcased in this first chapter, so the literature can be elaborated in more detail in the remainder of the thesis.

1.3 Theoretical evolution of resilience

In the 19th century, resilience was utilised in the engineering field to measure strength and assess the ability of materials to withstand shocks (Alexander, 2013; McAslan, 2010). Subsequently, the resilience concept emerged in the ecology domain from observations of natural systems by Holling (1973), where he assessed the natural environment's behaviour in relation to disturbances. Holling's observations led to the elucidation of two ecological behaviours: resilience and stability, of which were later termed as ecological (ecosystem) resilience and engineering (equilibrium) resilience (Holling, 1996; Holling & Meffe, 1996). His premise was that ecological resilience emerges in systems that are exposed to unpredictable surroundings that force changes to their configurations. This continuous exposure to disturbances amplifies behavioural reserves, thus promoting enhanced adaptive ability and therefore resilience (Holling & Meffe, 1996). Whereas engineering resilience is

focused on retaining stability with the impetus of returning to equilibrium within a linear and homogenous environment where changes are well-known and consistent (Holling, 1996). Akin to command-and-control management, engineering resilience manages variations and disruptions in an isolated way towards a single equilibrium, thus not exposed to a diverse range of shocks and stresses.

For the interest of clarity, within the discipline of safety science focused in high-reliability organisations (HRO), ‘resilience engineering’ although sometimes misapplied interchangeably as ‘engineering resilience’ (Badia et al., 2020), has been evolving in the last 25 years as a discipline that embraces adaptive capacity, organisational behaviour and culture (Hollnagel et al., 2011). However, its focus has been to identify things that go right from a safety perspective and maximise them in HROs.

Following findings from Holling, resilience in socio-ecological systems was then analysed through the lens of systems thinking to understand the resilience linkages between societal and environmental phenomena (Adger, 2000; Desjardins et al., 2015). For instance, early work on resilience by Timmerman, (1981) already examined society’s resilience to climatic variability. According to Adger, (2000) social resilience and ecological resilience are interdependent given that social systems depend on the environment, likewise ecosystem services are also affected by the norms, rules and behaviours that govern social systems. Despite natural sciences’ prominent analysis, other disciplines - including business, psychology, infrastructure - have also explored the concept in relation to their field of work (Alexander, 2013).

Resilience initiatives encompass various spatial scales (micro, meso, and macro), temporal scales (short, mid and long-term), and fields (organisational management, natural

environment and infrastructure systems) (Alexander, 2013; Folke et al., 2010; Macrae, 2019). Organisations may also strive for two types of resilience: (1) specified: often articulated as resilience from ‘what to what’; and (2) general: a more abstract capability derived from the emergent behaviour of individuals and systems (Folke et al., 2010; van der Merwe et al., 2018). Both resilience approaches (specified and general) should strive for a balance between both types as they complement each other. For instance whilst specified resilience is quite tangible and narrow as it targets specific threats, general resilience emerges from the adaptive interactions and behaviour of individuals and systems to manage unforeseen and unpredictable threats (Carpenter et al., 2012).

Furthermore, resilience can be applied in different moments: prior, during and after a disruptive event. Several frameworks have been devised to capture the different temporal scales of resilience, such as the resilience analysis grid (RAG) – monitor, anticipate, learn and respond - by Hollnagel, (2011). Similarly, but from a different perspective, Ducheck, (2020) conceptualised resilience in three stages (1), anticipation; (2) coping; and (3) adaptation. Ducheck, (2020) posits that all three stages influence each other’s effectiveness, thus highlighting the importance of continuous learning to adjust processes and behaviours, based on the outcome from each stage.

As an umbrella concept, resilience is composed of complementing principles such as robustness, redundancy, rapidity, adaptiveness and risk management (Anderies et al., 2013; Brown et al., 2017; Bruneau et al., 2003; Engle & Lemos, 2010). Such principles may be built in physical realms through infrastructure, assets, and technologies, as well as within human domains including the organisational environment, organisational culture, and relationships with stakeholders. An example is van der Merwe's et al., (2018) resilience framework for CIS encompassing the engineering and social environments.

Despite the variety of disciplines that have adopted resilience as a guiding concept and resilience's multifaceted characteristics, there are some theoretical gaps attached to the concept that must be recognised. For instance, the overly normative assumptions surrounding resilience (Moser et al., 2019), may prevent the visualisation of resilience inequalities amongst different systems and communities. Especially because developing the resilience within a single system, if applied narrowly, may increase the vulnerability of other systems and communities.

Another gap in knowledge is that different fields and disciplines often do not cross-pollinate on their varied perceptions of the concept. This has led to a siloed evolution of resilience (Macrae, 2019) where several interpretations and objectives of resilience have progressed in isolation with very few research and practical attempts (Davoudi et al., 2012) to interpret and analyse potential cross-overs from different fields and disciplines (Brand & Jax, 2007; Macrae, 2019; Rodina, 2019a). This was depicted by Smith, et al (2019) who have exemplified an epistemological divergence, where water professionals would narrowly view the concept within the lenses of their specific department or area of work, as opposed to having a broader view of resilience towards achieving strategic objectives.

The islands of knowledge in resilience research and practice may narrow how resilience is articulated and implemented in practice, thus potentially leading to blind spots when sense-making the internal and external environment in preparation of threats. Such silos in literature may be attributed by the different epistemological and ontological views that underpins the application of the concept (Davoudi et al., 2012; Naderpajouh et al., 2018) and that have not been fully reconciled (Rodina et al., 2017). In the water sector this gap is also illustrated by the over-emphasis of resilience initiatives and research that are focused in the built

environment, with few enquiries on the organisational and social domains (Lawson et al., 2020).

1.4 **Conceptual Perspective: Organisational Resilience**

Although infrastructure and OR concepts currently share fundamental principles of sustaining a systems' functionality, they convey different priorities and context. Accordingly, they pursue different foci; infrastructure resilience is mostly centred on managing specified threats to physical assets towards withstanding threats (van der Merwe et al., 2018) and OR more strongly revolves around the culture, relationships, behaviour, and resources within the corporate environment (Brown et al., 2017; Crick & Bentley, 2020).

Assessing the resilience of water utilities from the sole lenses of infrastructure resilience, may prevent an in-depth appraisal of the breadth of factors and systems that may contribute or hinder the resilience of water services. In addition, given this thesis emphasis on examining the under-investigated human dimensions of resilience in the water sector, OR is applied throughout this study.

More specifically, this study is underpinned by the OR model posited by Lengnick-Hall et al., (2011) due to its three-dimensional structure that covers tangible and intangible actions and resources (as seen below) and it is further elaborated in Chapter 2 of this thesis:

- (1) **Cognitive:** Values and beliefs that contribute to timely and effective interpretation (sense-making) of growing trends that translate into a favourable behaviour of OR.
- (2) **Behavioural:** Ability to manage complexity by proactively and dynamically employing unconventional and standardised responses based upon what generates the best outcome for the organisation's short and long terms.

(3) **Contextual:** Underpinning structures (people, relationships, processes, and resources) that generate cognitive and behavioural characteristics conducive to OR.

The framework from Lengnick-Hall et al., (2011) was chosen as the analytical lens due to its three-layered description of OR properties (cognitive, behavioural and contextual), and extensive elucidation of how OR is manifested in practice with reflections that cover internal members, organisational perspectives and interactions with stakeholders (micro to macro). As such, the chosen framework supports insights that navigates different scales – from individuals to organisation and stakeholders - and cognitive, behavioural, and contextual structures.

OR was selected as an underpinning conceptual perspective for this research due to the following considerations:

- OR delves in more detail into the culture, behaviour, relationships, and tangible and intangible resources.
- In the context of water utilities OR may broaden perspectives of the crucial role of human capabilities in supporting resilience to complement the current emphasis in research and practice of managing specified threats to shield physical infrastructure.
- OR may expand awareness of threats deriving from organisational and social domains to practitioners.
- The development of OR capabilities may provide a significant impact to resilience advancements in utilities due to being an under-developed area in research and for the water sector.

OR has been articulated mostly in the organisational management field, with some studies signposting characteristics of OR through1 prescribed frameworks (Denyer, 2017; ResOrgs,

2012) illustrating the dynamics of different OR capabilities through empirical evidence (Gover & Duxbury, 2018) and through systematic appraisal of literature (Hillmann & Guenther, 2021). Although such studies provide useful descriptions of OR's characteristics as seen in table 1-1, they often fail to provide a more detailed and structured account of how OR capabilities are manifested in the values, beliefs and behaviour of personnel, organisational culture, and the organisation's internal and external environment. In addition, such a structured and detailed examination of OR, to the author's knowledge, has not taken place in studies for the water sector.

Table 1-1: Different conceptualisations of OR.

Organisational resilience seen as:	Study:
Ability to anticipate and effectively read the environment underpinned by relational, emotional, cognitive, structural resources and behaviour that leads to effective responses.	(Burnard & Bhamra, 2011)
Ability to: (1) read and react to disruptions, (2) set strong organisational purpose and values, and (3) build innovative and dynamic adaptation.	(Coutu, 2002)
Appropriate management of organisational tensions (contrasting behaviours) and different temporal processes (foresight, insight, oversight, and hindsight).	(Denyer, 2017)
Combination of capabilities (proactive, reactive, cognitive, and behavioural) conceptualised through stages: anticipation, coping and adaptation.	(Duchek, 2020)
Integration of strategies that focus at enhancing capabilities in the built environment and social dimensions.	(Gibson & Tarrant, 2010)

Underpinned by social capital and financial reserves.	(Gittell et al., 2006)
Multi-layered conceptual model: people, organisational context for change, organisational processes, and the external environment.	(Gover & Duxbury, 2018)
Ability to change before the need for change becomes too imminent.	(Hamel & Valikangas, 2003)
OR is underpinned by a creative climate that is conducive of innovation.	(Mafabi et al., 2015)
Diversification of innovation strategies.	(Reinmoeller & Van Baardwijk, 2005)
As a strategy that is built by three main indicators: (1) leadership and culture; (2) networks and relationships, (3) change readiness.	(ResOrgs, 2012) and (Brown et al., 2017)
Setting appropriate organisational and national cultures that produces an environment conducive of OR.	(Sawalha, 2015)

As the main context for this research, water utilities are quite unique in their functioning in comparison to organisations that navigate the free market and strive for competitive advantage and profitability. Different to organisations that are pressured by levels of productivity, sales, and profit when disruptions occur, (Sheffi & Rice, 2005) water utilities incumbency primarily lie in protecting and sustaining continuous functionality.

As a CIS, water utilities often function as natural monopolies, thus experiencing a certain degree insulation against the wide-ranging jolts from the free market (Leong & Li, 2017; Pawsey et al., 2018). This may delay the need for water utilities to reinvent themselves and develop OR capabilities. Especially because water utilities have a strong legacy of building long-lasting systems, that according to Chester and Allenby, 2019, may lead to “locked in” outcomes or the perpetuation of old strategies despite the need for renewal and the

identification of new ways to manage complexity. This lock-in can not only be manifested in the planning and management of infrastructure but also in the organisational norms and beliefs, thus preserving old ways of doing things and hindering the development of OR capabilities (Helmrich & Chester, 2020).

In addition, water utilities are sensitive to local shocks and stresses, given that water is supplied by regional companies to communities within a local boundary (Dunk et al, 2012). This differs, for instance, from energy companies, where the supply is often not location-dependent, and energy can be imported/exported from and to different global regions. Water supply's tie to local availability make water utilities more vulnerable to pollution, extreme weather events, water scarcity and reputation damage at local level, this further underscores the need for the development of OR capabilities.

Therefore, water utilities are an interesting context for the investigation of OR, as they are relatively insulated from the need for transformative change, coupled with a strong legacy of rigid fail-safe systems and the 'lock-in' of old ways of doing things which bleeds over to organisational norms and beliefs. However, water utilities' stronger vulnerability at local level warrants a more timely development of agility and adaptability, not only in physical assets, but also in the tacit beliefs and value systems of water organisations.

1.4.1 Organisational culture, organisational resilience, and the water sector

Many studies share a common understanding that the capabilities that trigger, build and maintain resilience in organisations are very much rooted in the characteristics of the organisational culture (Denyer, 2017; Gibson & Tarrant, 2010; Harrison et al., 2017; Hollnagel, 2014). Organisational culture has been theorised as a combination of shared values and beliefs that shape behaviour (Summerill et al., 2010), as collective meanings and views

that steer appropriate responses (Weick & Sutcliffe, 2015), and structured as organisational artefacts, values and beliefs, and underlying assumptions (Schein & Schein, 2017). Others went as far as saying that adaptive capacity (a key tenet of resilience) is highly dependent on the organisational culture (Zaato & Ohemeng, 2015). Ultimately, organisational culture is assumed to enable or hamper positive changes to organisational behaviour (Johnson, 1992) and is the organisational learning outcome to changes in the external and internal environment (Schein & Schein, 2017) that could be conducive to or maladapted against OR.

According to Lengnick-Hall et al., (2011) a culture of OR hybridises organisational responses towards the most appropriate intervention to manage a particular threat. Elsewhere, Tangenes & Steen, (2017) suggest that an organisational culture of OR is centred on the sharing of information across the organisation through effective collaboration, whereas Burnard & Bhamra, (2011) emphasise on the importance of cultivating an organisational culture of learning to build OR. From the level of personnel, some OR studies have noted that a positive culture that promotes joy (Hartmann et al., 2021) and well-being (Malinen et al., 2019) has a direct positive impact on individuals' sense-making and coping capacity when responding to threats.

The varied views of an organisational culture conducive to OR suggests a lack of consensus on the cultural characteristics that may support OR. Current dissensus is also manifested in practice, given that different regional and technical cultures may have differing perceptions of what they consider to be effective resilience measures in organisations. A study made by Zimmermann et al., (2014) in the aviation sector, exhibited how people from different cultural contexts (occupational, regional, and cultural backgrounds) have varied beliefs with regards to where and how incidents occur and where and how resilience efforts must be devoted and implemented.

As a cognitive property, organisational culture is crucial in developing OR. However, research is needed to identify in more detail key characteristics that encompass a culture of OR. As such, organisations may be better equipped to re-design or change values and beliefs towards OR with a more clarified goalpost.

Similarly, in the water sector some studies have emphasized the importance of culture in ensuring a commitment to a resilient service (Summerill et al., 2010), or have flagged a need for an organisation culture to change (Baker et al., 2018) or the need to clarify how to align an organisational culture with the resilience aspirations for the water sector (Smith et al., 2019). A learning culture (Baker et al., 2018; Smith et al., 2019), that strives for continuous development (Summerill et al., 2010), with positive recognition and remuneration (Zaato & Ohemeng, 2015) are some of the few cultural characteristics perceived to support the development of resilient water services.

Although culture is noted in some resilience studies for the water sector, they are scattered, inconsistent and lack validity from practitioners. Current theory therefore lacks a one-stop resource that identifies and combines cultural attributes conducive to OR that is empirically endorsed by water sector representatives. This is problematic because, due to the centrality of culture in shaping beliefs, values and behaviour, lack of understanding of an organisational culture of OR may hamper the development of significant resilience efforts in the water sector.

1.4.2 OR and stakeholders

Water utilities exist to serve society whilst inserted in a complex environment where events within other systems and decisions by stakeholders may impact water services' functionality. Therefore, it is illogical to just observe the behaviour of a specific CIS without accounting other interdependent systems and stakeholders (Rinaldi et al., 2001). CIS can no longer plan

for disruptions guided by specified threats to their system alone, but they also have to be aware of and examine unintended crises beyond their physical boundaries (Brown et al., 2017). Especially because the interdependency of CIS can lead to non-linear events and interactions, thus making difficult to predict disruptions (Chester & Allenby, 2019). As such, broadening utilities' perspectives of potential threats deriving from different sources can prevent organisational blindness and enhance preparedness.

Stakeholder engagement – in the form of positive collaboration with other water utilities, different CIS, regulators, and customers – has been claimed to support the widening of views on potential threats and prevent misconceptions (Tepes & Neumann, 2020). As part of OR's contextual property (Lengnick-Hall et al., 2011), internal and external social networks with stakeholders are one of the underpinning factors that enable the development of OR. These networks foment knowledge exchange, development of social capital towards strong collaboration in moments of crisis and better awareness of interdependencies (Lengnick-Hall et al., 2011). Accordingly, stakeholder engagement has been recognised as an important enabler of resilience (Rodina, 2019a), as it supports more comprehensive awareness of the external and internal environment, can augment organisational resources (Gover & Duxbury, 2018) encourages novel and innovative thinking (Crick & Bentley, 2020), enhances preparedness, adaptiveness and flexibility (Biddle & Baehler, 2019; Snel et al., 2020).

1.4.3 *Water customers and resilience*

As water utilities are compelled to adapt their systems and behaviour in preparation for more regular and unpredictable events, such endeavour competes with an organisational environment that is stretched for resources (Chester & Allenby, 2019) as well as external pressures, such as higher expectations from customers (Ofwat, 2017).

For the water sector understanding the link between interactions with stakeholders and utilities' resilience has been noted as a crucial research priority (Rodina, 2019a; Smith et al., 2019). Specifically to understand and manage the trade-offs involved deriving from different customers' needs and preferences (Heino & Anttiroiko, 2016) given that different customer segments may have disparate opinions on the required level and initiatives of resilience (Dziedzic & Karney, 2016) which may also differ from the perceptions of water utilities on what is best for customers.

Advancing customer engagement has been an emerging and important piece within the resilience agenda for the water sector (Wallis-Lage, 2015). Especially because disengaged customers (Baker et al., 2018) that do not value water services (Golladay et al., 2020) have been increasingly acknowledged as key threats to water utilities resilience. Notably, the relevance of customer engagement is exemplified through some resources that advise water utilities to consider the priorities of water customers prior to devising their own resilience metrics (Rodríguez et al., 2020; UKWIR, 2017).

Customer engagement in resilience discussions has been strongly attached with the intent to ensure fair price-setting (Ofwat, 2016), by attaining a better understanding of current and future needs of customers (Baehler & Biddle, 2018) and their preferences on resilience levels (Johannessen et al., 2014). In parallel, information-sharing, positive reputation and collaborative behaviour have also been observed as key resilience capabilities that should be leveraged through enhanced customer engagement in the water sector (Baker et al., 2018; Biddle & Baehler, 2019).

However, customer engagement has not been maximised in the water sector, given it generally takes place reactively when responding to customers' complaints (Akhmouch & Clavreul,

2016), or very superficially as unilateral top-down approaches (Akhmouch & Clavreul, 2016). Such sub-optimal levels of customer engagement has been exemplified by water practitioners' who have recognised its irregularity and the need to do more (Biddle & Baehler, 2019), even though empirical work evidenced a strong desire by water professionals for a wider two-way engagement with water customers (Baehler & Biddle, 2018). This is problematic because, fomenting social networks with important stakeholders, such as water customers, is crucial for the development of contextual properties of OR in organisations (Gittell et al., 2006; Lengnick-Hall et al., 2011). Therefore, although the benefits of customer engagement have been elaborated for the water sector (Biddle & Baehler, 2019; Golladay et al., 2020), little has been articulated in literature on the direct links of enhanced customer engagement and resilience.

More specifically and beyond customer engagement, there is a dearth of understanding of how customers can support the resilience of water utilities, given that they derive utility from water services and their values and behaviour have a direct effect on the level of vulnerability or resilience of water utilities. The plurality of preferences in different customer segments as well as financial, social, and psychological factors also influence customer behaviour and the steer for resilience in water utilities (Cahn et al., 2020).

In addition, as a property of OR, relationships within and outside water utilities promote social capital, networks and diffuse power and accountability. Interpersonal connections with water customers can serve as resources to more swiftly adapt to uncertain and disruptive events (Lengnick-Hall et al., 2011) or as a buffering capability for when in moments of need.

Beyond customer and/or stakeholder engagement, there is a need to explore the roles water customers could play in supporting water utilities' resilience. This can expand understanding

of external and untapped positive capabilities and enable utilities to better target efforts for the development of OR. Capturing the breadth of customers' roles in more detail can uncover positive yet under-valued roles or negative and overlooked ones. Given that water managers experience the daily challenges of delivering sustained services, capturing the roles of customers from their perspectives can broaden understanding on the limitations of water utilities in building resilience in an isolated way and the resilience-value of reinforcing positive customers' roles. This way, water utilities can devote efforts to maximise customers' roles conducive to resilience and address roles that increase the vulnerability of the water sector.

1.5 Overall Methodological Approach:

The cumulative interaction of behaviour and values amongst individuals in utilities provide the sentience capacity that influence utilities emergent behaviour and their continuous functioning (Hollnagel, 2014). Given the social and organisational nature of this research, the assumptions of this thesis follow the ontological line of thought that humans create and transform reality (Bryman, 2012).

Based on the premise that developing properties of OR is heavily influenced by the complex interactions of organisational insiders (Crick & Bentley, 2020; Hollnagel, 2014; Lengnick-Hall et al., 2011; Naderpajouh et al., 2018), a constructivist approach underpinned the direction of the researcher's inquiry. Constructivism assumes that reality is developed by the individuals that are actually immersed in a particular environment where the phenomenon of interest takes place (Schwandt, 1994). As individuals are constantly shaped by different environments and social interactions, reality is in constant flux of construction and reconstruction (Bryman, 2012).

As observed above, water utilities are quite unique organisations due to its monopoly nature that may lead to a sluggish realisation of the need to implement changes (Leong & Li, 2017). This is coupled with their strong legacy of seeking system's robustness and rigidity, which may lead to path dependencies (Chester & Allenby, 2019) that prevents timely renewal towards their more acute sensitivity to local disruptions. However, as the need for change becomes more apparent - due to novel shocks and stresses - the demand for agile and adaptive capabilities pressure changes to human behaviour and interactions in such organisations. The constructivism stance adopted here also seeks to understand individuals' reluctance or willingness to shape reality for the future through new capabilities that support functionality in an organisational context that tends to seek equilibrium and may contradict principles of OR.

Therefore, attaining a better understanding of the organisational environment water utilities are immersed in to assess the conduciveness of OR requires insights from individuals that experience daily life in utilities and who are also active in building and transforming utilities' resilience reality (Schwandt, 1994).

The sample capacity across the chapters is up to 31 water utilities' representatives. Although the sample is not statistically generalizable (Tsoukas, 2009), the insights drawn focus in the peculiarity of cases to expand understanding of how OR is employed and perceived by international water utilities (Tsoukas, 2009; Buchanan, 2012). As such, the epistemological value from this modest sample is to broaden and refine perspectives on how OR can be manifested in international water utilities, as opposed to negating/creating theories of OR. The international nature of this research, enables the exploration and comparison of water utilities from different contexts, thus aiding the detection of differences and similarities on OR (Fitzgerald & Dopson, 2009). In line with Tsoukas (2009), this study provides analytical

refinement by uncovering peculiar empirical manifestations (heuristic generalisations) towards refining and further specifying the analytical understanding of OR in different water utilities.

In order to derive underlying meaning from socially constructed phenomena, the researcher based this research on methods that support deep interpretation. As such, interpretivism was employed as the epistemological paradigm due to its main premise that attaining knowledge of the distinct nuances of a social phenomenon requires extensive interpretation of social experiences (Bryman, 2012). Utilising interpretivism as the choice for reflections and decisions by the researcher also enabled context-specific insights that captured views on the social and organisational environment in international water utilities in relation to OR.

In view of this research's pursuit of advancing knowledge through the lenses that reality is socially constructed and can be better interpreted through the examination of individuals' perceptions, an inductive approach influenced the analysis of this research. An inductive technique was applied due to its mechanism of not having to align tightly with previous theoretical frameworks, instead it focuses on creating meaning from the data derived from organisational members in utilities who ultimately build and shape reality (Braun & Clarke, 2006). The researcher was also aware that the analysis of data would not be completely detached from previous theories and the researcher's initial understanding about the subject of enquiry, even though the analysis was predominantly applied inductively.

The focus was to capture rich qualitative data as well as to apply analytical tools that embraced depth of meaning through substantial interpretation. The research methods were applied systematically with extensive illustration of the evidence from empirical data. The researcher was cognisant throughout the study of the potential for personal biases blurring the steering

of inquiry and interpretation of the findings. This was managed through extensive analysis of this research dataset, a strictly professional interaction with participants, and support from supervisors in assuring neutrality in the thinking of the researcher.

Qualitative methods that accommodate depth of meaning were the predominant strategies utilised for data gathering due to its ability to grasp the pluralism and complexity of the social world (Bryman, 2012). For instance, semi-structured interviews were conducted with representatives from international water utilities given its ability to generate in depth insights from different perspectives and its flexible structure that allows new ideas to be brought by the participants (Adams, 2010). In addition, a validation survey through a qualitative delphi approach in chapter 4 served as an accessible tool to capture depth from different perspectives whilst overcoming some logistical challenges posed during the COVID-19 pandemic.

Thematic analysis was employed as the main analytical method across this thesis (Braun & Clarke, 2006). As a well-established and popular method in qualitative studies (Braun & Clarke, 2019), the thematic analysis approach by Braun & Clarke (2006) is epistemologically agnostic and is centred on identifying patterns of meaning across a specific dataset. As this thesis is positioned in the interpretivism and constructivism realms, the analysis and coding exercise delved into the socio-economic contexts of participants and how utilities' members understood their organisational reality and experience in relation to OR (Gioia et al., 2013).

The creation of themes and sub-themes across this thesis, as per thematic analysis traditions, does not focus in the frequency of mentions, but the relevance and importance of specific data extracts in relation to the research questions (Braun & Clarke, 2006). The main aim was to capture meaningful extracts of socially constructed phenomena that related to the research questions as opposed to the frequency of their occurrences (Gioia et al., 2013).

The researcher ensured rigour of the coding process from the very outset of devising the interview protocol. For instance, the researcher conducted several iterations to the interview questions prior to the interviews, to ensure they were aligned with the main research questions and were free from leading questions that could influence the participants views on a specific topic (Gioia et al., 2013). The potential of bias in the coding process was managed through extensive discussions with supervisors who regularly critiqued the researcher's interpretation and suitability of the themes – see more in table1-2 (Gioia et al., 2013). During the discussions on the thematic maps (hierarchical structures of meaning: codes, sub-themes, and themes) (Braun & Clarke, 2006) if the content was not agreed among supervisors and the researcher and if they had very different interpretations the thematic maps were re-visited. This process took place to ensure higher confidence in the structure of the findings and insights (Gioia et al., 2013).

The following phases of thematic analysis (Braun & Clarke, 2006) were employed for the creation of themes observed across the chapters of this thesis:

- 1) **Data familiarisation:** iterative reading and appraisal of the data corpus documenting initial insights and patterns;
- 2) **Initial coding:** coding of initial insights by giving equal attention and importance to each data item;
- 3) **Searching for themes:** Collation and appraisal of codes into themes (broader patterns of meaning) and sub-themes;
- 4) **Revision of themes:** refinement of candidate themes, removal of ineffective themes (iterative process of reading and re-reading, and coding and re-coding the dataset to assess the singularity and effectiveness of themes).

5) **Defining and naming themes:** further refinement of themes and assessment of the coherence (coherence on the hierarchy of meaning) between themes, sub-themes, and codes.

A final thematic mind map is observed below as an example of the structure and rationales utilised for the creation of themes seen across this thesis. Figure 1-1 showcases a thematic map based on the dataset utilised in chapter 2 of this thesis.

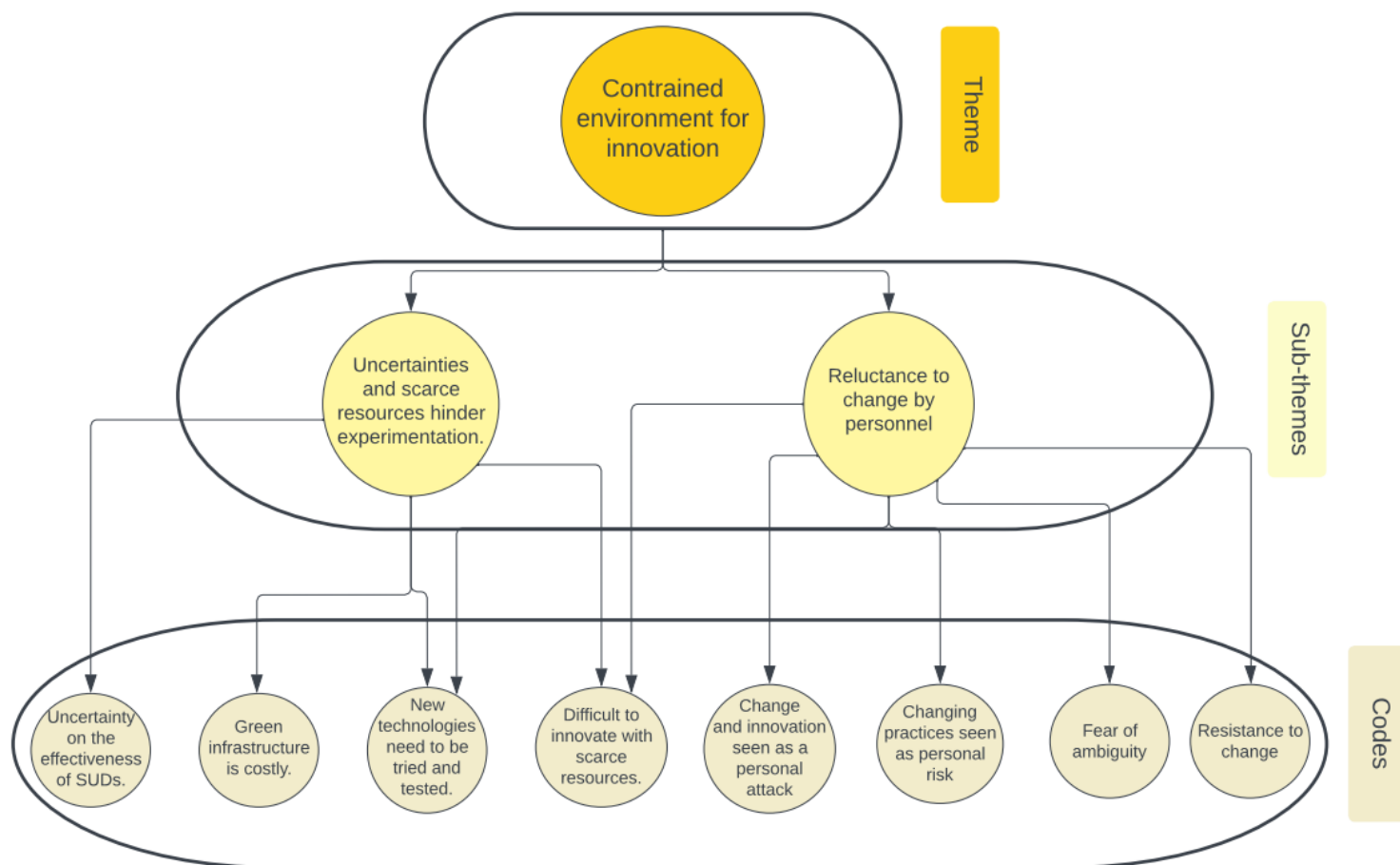


Figure 1-1: Illustration of a thematic mind map with the logical hierarchy of codes, sub-themes, and themes for the creation of meaning.

The dataset attained from the interviews directly contributed to chapters 2 and 3. The interviews focused on understanding the challenges and opportunities of adapting and developing social and organisational capabilities conducive to resilience in water utilities. Two pilot interviews also took place with relevant representatives from the water sector to refine and assess the suitability of the questions in the proposed interview topic guide utilised by the researcher to steer the interview structure.

In chapter 4 the creation of a cultural framework of OR tailored for water utilities was based primarily on appraisal of latest literature evincing cultural attributes that support resilience. Once the framework was constructed, its suitability for the water sector was assessed by consulting the participants on areas that needed to be changed and improved given their extensive experience of working in water utilities. The findings for chapter 4 derived from two rounds of surveys containing closed (quantitative) and open-ended questions (qualitative). The surveys had the intent of refining and validating a cultural framework of OR for the water sector with the closed questions capturing quantitative responses to assess consensus and open-ended questions to explore relevant themes.

Finally, Table 1-2 provides an overview of the considerations made throughout this study to ensure its trustworthiness (validity and reliability). With the understanding that the social world is always in flux, validity and reliability as assessed in positivistic-based research would not be appropriate in this study (Cypress, 2017). Therefore credibility, transferability, dependability, and confirmability were employed as the main indicators of rigour in this thesis.

Table 1-2: Reflections on the trustworthiness (validity and reliability) of this thesis, which was based on the criteria from Bryman, (2012), Cypress, (2017) and Noble & Smith, (2015).

Credibility (internal validity)	Transferability (external validity)	Dependability (reliability)	Confirmability (objectivity)
- This thesis followed well-established research and analytical methods for qualitative data, e.g.: semi-structure interviews, thematic analysis, and qualitative Delphi. - Debriefing and reflexive discussions were conducted regularly with other researchers to address potential biases. - Member checking: analysis of the semi-structured interviews was presented to some	The context of participants from different countries is considered throughout. A more detailed consideration is given specially in relation to regions containing a stark contrast of their quality of water services such as high and middle-income countries. The analysis, carefully examined the uniqueness of perspectives from different regions. The transferability of findings, given the small sample of this study, is centred in providing analytical refinement by broadening perspectives of OR in different contexts rather than proving or disproving theories	The decision-making of different phases of this research - such as setting the study's aim and objectives, selection of sample and data analysis – was consulted with supervisors who challenged and criticised assumptions and decisions from the researcher.	The rationale of the analysis of each research output was shared with peers to ensure that individual values of the researcher were not clouding their analytical judgement. Strategies for analysing data were also extensively documented and presented to supervisors and participants.

participants, and during the surveys the participants had the chance to review and validate their individual and group responses.	(Tsoukas, 2009; Buchanan & Denyer, 2013).		
---	---	--	--

1.6 Thesis Plan

Based on the aim and objectives displayed in figure 1-2, the remainder of this thesis is arranged as a series of chapters, most of which are formatted as journal articles (with the exception of chapter 5). As observed, the introduction to this thesis context, rationale and a brief literature review were presented in chapter 1. As this thesis is structured by papers, as opposed to a monograph, a literature review in support of objective 1 has also been included throughout all the remaining chapters.

Chapters 2, 3 and 4 utilise interpretative research methods to capture the perceptions from international water utilities' representatives relating to OR. Chapter 2 delves deep into the organisational environment by applying thematic analysis (Braun & Clarke, 2006) to the findings generated from semi-structured interviews. It assesses the challenges to developing an organisational environment conducive of OR in water utilities. It does so by critically analysing the themes derived from the analysis, against the OR analytical framework by Lengnick-Hall & Beck, (2005). The findings highlight dominant OR challenges pertaining the cognitive and contextual properties in water utilities. The appraisal of challenges against resilience literature also enabled a better understanding of the implications of these challenges to water utilities. Chapter 2, therefore, more closely responds to objective 2 as it provides

clarity on the challenges and opportunities of adapting organisational capabilities to build OR and the implications to water utilities. The empirical findings also reinforced some knowledge gaps identified from chapter 1, specifically around the role of customers and lack of clarity on the characteristic of an organisational culture conducive to OR.

By building on the contextual property of OR (Lengnick-Hall et al., 2011), chapter 3 investigates the role of customers in building OR from the perception of water utilities' representatives. This chapter elucidates ways that customers can support water utilities in building OR as well as the different perceptions on the necessary initiatives of customer engagement to facilitate and maximise the positive role of customers. Thematic analysis is also employed in this study and displays key patterns of meaning relating to customers' role in building OR in water services. The themes are then appraised against current literature in the topic to assess theoretical advancements as well as challenges, and opportunities for the water sector. Given that this chapter explores the under-investigated role of customers in building water sector resilience, it addresses objective 3 as it illustrates the perceptions regarding social capabilities of resilience with external stakeholders - which in this chapter the researcher focuses on water sector customers.

Chapter 4 appraises current literature on cultural attributes conducive to the OR of water utilities. Through this process a cultural framework of OR was devised and posed for the scrutiny of water sector professionals through iterative surveys. A delphi approach composed of two survey rounds was utilised to capture the participants perceptions about desirable attributes of an organisational culture for OR and to conduct a framework validation process. The survey responses were analysed quantitatively and qualitatively. The iterative nature of the surveys resulted in the refinement of the framework which enhanced its suitability for the organisational context of water utilities and coherence to the views of utilities'

representatives. Once consensus was reached amongst the participants the framework was then validated. Despite the construction of a cultural framework that identifies desirable outcomes of an organisational culture for OR in the water sector, this chapter also elaborates in more detail key cultural characteristics conducive of OR and explores the linkages between organisational culture and OR. Given the chapter's focus of unpicking the characteristics of cultural attributes conducive of OR in water utilities, this chapter directly responds to objective 4 of this thesis.

This thesis is then concluded in chapter 5 through an overview of the main theoretical contributions generated by previous chapters – theoretical replication, extension - contradiction, and creation of new theories - as well as a discussion on challenges and opportunities. Chapter 5 reinforces the complexity and significance of building social and organisational capabilities aligned with OR principles for the water sector and brings all the chapters' together. It also provides a summary on the key insights generated for water utilities, gaps in knowledge identified and recommended areas for future research. This chapter is composed by summary of findings, followed by the transversal challenges and opportunities to embedding OR, implications for policy, methodological reflections and contributions, implications for the water sector, and future research.

The structure of the thesis is reflected in diagrammatic form below which illustrates the linkages between the objectives, chapters and research methods and their contribution to this research aim.

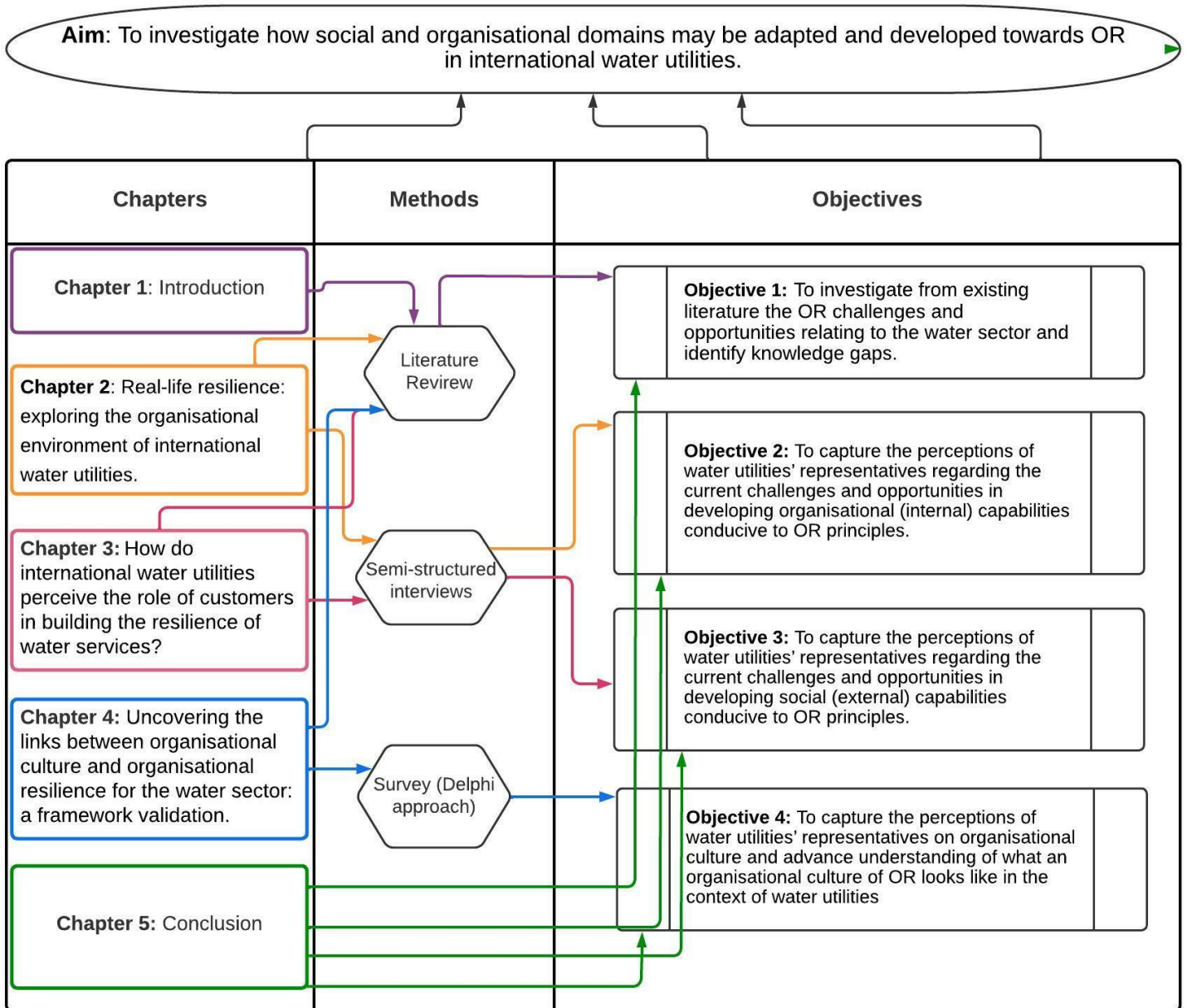


Figure 1-2: Diagram illustrating the linkages between the aim, chapters, methods and objectives of this thesis.

*Supplementary material has been added in appendix J: evidence table containing example quotes and thematic mind-map.

2 Real-life resilience: exploring the organisational environment of international water utilities.

Giffoni, E., Jude, S., Smith, H. M., & Pollard, S. J. T. (2022). Real-life resilience: Exploring the organisational environment of international water utilities. *Utilities Policy*, 79, 101394. <https://doi.org/10.1016/j.jup.2022.101394>

Abstract

The water sector has signalled the need to advance organisational and social resilience efforts. There is a lack of understanding of whether the organisational environment in water utilities is conducive to organisational resilience. Themes from interviews showcased challenges related to cognitive and contextual organisational properties. We identified a need to broaden the cognitive frame of utilities to account for flexible concepts for enhanced sense-making. We propose categories of organisational silos and a set of cultural attributes that contribute to organisational resilience. Interventions are needed to develop the cognitive, behavioural, and contextual properties of utilities that support organisational resilience.

2.1 Introduction

Resilience is recognised to help organisations prepare for, manage and thrive against the effects of chronic and acute disruptions (Sheffi & Rice, 2005). Despite the disciplinary evolution of the concept and its increased prominence, scholars and practitioners still struggle with interventions to build and sustain resilience (Moser et al., 2019). In particular, integrating

different sub-domains of resilience, such as social and organisational, remains one of the main challenges (Macrae, 2019; Moser et al., 2019; Naderpajouh et al., 2018; Rodina, 2019), especially when managing critical infrastructure systems (CIS) (Brown et al., 2017; Crick & Bentley, 2020).

The resilience of CIS, such as water utilities, is paramount for society (van der Merwe et al., 2018). Water utilities have the complex duty of ensuring ongoing water and wastewater services against a backdrop of increasingly complex shocks and stresses (Baehler & Biddle, 2018; Brown et al., 2017). Within the water sector, resilience discussions are traditionally dominated by technocratic and engineering perspectives (Akamani, 2015; Crick & Bentley, 2020; Rodina et al., 2017). Increasingly, however, water sector professionals and scholars are emphasizing multiple domains of resilience through more comprehensive resilience approaches that also account for organisational and social capabilities (Akamani et al., 2015; Crick & Bentley, 2020; Naderpajouh et al., 2018; Rodina et al., 2017; Smith et al., 2019). For this study, resilience refers to the organisational resilience concept which encompasses capabilities to manage internal and external threats. Therefore, we posit that organisational resilience is the collective ability to absorb, adapt and capitalise on shocks and stresses (Lengnick-Hall et al., 2011).

Accordingly, from an organisational perspective, precursors to disruptive events may be linked to organisational behaviour and culture (Taylor et al., 2017). In addition, the water sector has indicated an increasing recognition of the importance of human agency in the resilience of water utilities (Crick & Bentley, 2020; Lawson et al., 2020; Ofwat, 2017; Smith et al., 2019), especially as humans have a significant influence on vulnerabilities of physical assets (Chester & Allenby, 2019). Therefore, insights on these issues from water sector personnel may support a better understanding of the current organisational environment in

water utilities and whether it is conducive to resilience initiatives. The term ‘organisational environment’ is applied in this paper as the internal dynamics, perceptions and values of water utilities that influence organisational resilience performance

The authors have had a long-standing research interest in the organisational journeys that water utilities are undergoing; from engineering risk and asset management through to corporate risk governance and, more recently, toward embedded organisational resilience (Chalker et al., 2018; Pollard et al., 2009; Pollard et al., 2006; Pollard et al., 2014; Tang et al., 2013). However, these developments are not simply a progression within a single domain because the concepts of risk governance, risk management, and resilience each draw in additional elements from disciplines not incorporated within the predecessor concept.

To examine the organisational resilience maturity of recent developments in detail, we draw from the internal cognitive, behavioural, and contextual properties of water utility organisations (Lengnick-Hall & Beck, 2005; Lengnick-Hall et al., 2011).

While studies of organisational resilience have been undertaken for the water sector (Crick & Bentley, 2020; Rodríguez et al., 2020), they often lack a clear definition of the concept. This gap may be linked to numerous conceptualisations of resilience that contribute to ambiguous and inconsistent understandings (Duchek, 2020). Organisational resilience is mainly described as a blend of traits, behaviours, resources and capabilities (Duchek, 2020; Gittel et al., 2006; Gover & Duxbury, 2018) that enable dynamic adaptation and sustained delivery of organisations’ products and services. Elsewhere, organisational resilience is seen as the appropriate management of tensions, such as efficiency and adaptive capacity, as well as temporal practices, namely: foresight, insight, oversight and hindsight (Denyer, 2017). Crucially, people, leadership and culture have been identified as the primary sources of

organisational resilience (Gittell et al., 2006; Gover & Duxbury, 2018; Mafabi et al., 2015; ResOrgs, 2012). A culture of organisational resilience has been described as an ambivalent vigilance of the *status quo* (Sheffi & Rice, 2005), a proactive organisational stance (Denyer, 2017) and a culture that embraces change through innovation and renewal (Chester & Allenby, 2019; Hamel & Valikangas, 2003; Mafabi et al., 2015).

In addition to varying perspectives, literature predominantly signposts characteristics of organisational resilience through attribute-based tools or prescribed frameworks (Denyer, 2017; ResOrgs, 2012; van der Merwe et al., 2018) that are often applied as organisational resilience assessments (Brown et al., 2017; Sweya et al., 2020). However, these can lack a detailed account of the reality in organisations and depth of understanding of the complexities of developing organisational properties conducive to resilience. Very few studies have attained a detailed picture of the realities of organisational resilience (Gover & Duxbury, 2018), especially for the water sector (Crick & Bentley, 2020). Therefore, there is a need for an in-depth understanding of the current organisational environments in water utilities, with approaches that focus on resilience assessments and explore the internal properties of utilities from the lens of a clearly defined notion of organisational resilience.

In this paper, we utilise the framework posed by Lengnick-Hall & Beck (2005) and Lengnick-Hall et al. (2011) as an analytical frame due to its detailed illustration of how organisational resilience is manifested in different properties within organisations. Organisational properties must be developed to build the capacity for organisational resilience and honed continuously as capabilities to sustain a resilient performance (Lengnick-Hall & Beck, 2005). Table 2-1 showcases descriptions and the manifested characteristics of the cognitive, behavioural, and contextual organisational properties that support resilience, thus allowing a more in-depth analytical assessment of the organisational environment. We believe that by utilising the

organisational properties below, as opposed to attributes-based frameworks (Denyer, 2017; ResOrgs, 2012), we can clarify, in more detail, the realities and complexities of building organisational resilience practically into water utilities.

Table 2-1: Analytical framework of organisational properties that support organisational resilience, adapted from Lengnick-Hall & Beck (2005) and Lengnick-Hall et al. (2011).

Organisational Properties:	Description:	Manifested as:
Cognitive	Values and beliefs (cultural identity) that contribute to timely and effective interpretation (sense-making) of growing trends that translate into a favourable behaviour of organisational resilience.	• Widespread understanding and commitment to the organisational vision and values. • Cognitive frame of ingenuity, flexibility, and decisiveness when confronting uncertainty to support effective responses and opportunities for development.
Behavioural	Ability to manage complexity by proactively and dynamically employing unconventional and standardised responses based upon what generates the best outcome for	• Cognitive elements are transformed into visible actions: bricolage, improvisation, pro-activeness, and resourcefulness. • Behavioural reserves composed of standardised well-scripted behaviour and the ability to implement

	the organisation's short and long terms.	organic responses based on the most suitable course of action.
Contextual	Underpinning structures (people, relationships, processes, and resources) that generate cognitive and behavioural characteristics conducive to organisational resilience.	Internal and external social capital, psychological safety (collective respect for unconventional and contentious ideas/solutions), diffuse power (inclusive decision-making), resource network (interpersonal connections that generate resources/solutions), accountability, and tangible and intangible resources.

Based on the analytical framework in Table 2-1, the research question is posed: “*What are the challenges water utilities face in developing the internal organisational properties that build organisational resilience?*”. Using interviews with a sample of managers from international water utilities spanning the public and private sectors in middle and high-income countries, we explore the operational realities of utilities and examine whether there is evidence of a material transition from good corporate risk governance toward organisational resilience in practice.

2.2 Methods

Semi-structured interviews were conducted with water utility representatives from Australia, Brazil, Canada, East Asia, Greece, Hungary, Netherlands, Portugal, UK and US. A semi-structured interview was selected to elicit supportable evidence from water managers (Adams, 2010). The semi-structured interviews established a focus for the interviewer while supporting the participants to voice a free flow of ideas and information based on their perceptions and experiences (Adams, 2010). The interviews sought to capture the current organisational

environment of utilities from different realities and geographical locations concerning organisational resilience. The geographical scope of this study was focused on middle and high-income countries with relatively well-established centralised utility services.

An interview topic guide provided a detailed account of the organisational domain of water utilities and perspectives on the current organisational environment and challenges faced in building resilience. The guide was informed by the main knowledge gaps identified from the literature and refined by two pilot interviews with relevant representatives from the water sector. The questions covered topics on participants' understanding of resilience, as well as their views on social and organisational aspects of resilience.

The sample was composed of managers and senior managers from international water utilities. Out of the 31 participants, 13 were selected purposively, as they were involved in a working group of the US Water Research Foundation research project that funded this study (see Acknowledgements). To prevent the predominance of project members, we recruited an additional 18 participants with no direct involvement through snowball sampling (Table 2-2). These participants were selected due to their strategic and tactical roles in influencing water utilities' resilience. Two participants were representatives of a Water Association from East Asia. The specific country where the Water Association is located has been omitted to maintain their anonymity.

Table 2-2: Characteristics of the participants in this study.

Region	Participant's area of expertise	Utility scope	Utility Type	Engaged in the project

Australia	Risk management	Clean water and wastewater	Public	X
Brazil	Research, development, and innovation (senior manager)	Clean water and wastewater	Public/private	
Brazil	Asset management and planning	Wastewater	Public/private	
Canada	Corporate governance	Clean water and wastewater	Public	X
Canada	Strategic projects (senior manager)	Clean water and wastewater	Public	X
East Asia	Water association	Clean water	Private (non-profit organization)	
East Asia	Water association	Clean water	Private (non-profit organization)	
Greece	Research, development, and innovation (senior manager)	Clean water and wastewater	Public/private	
Hungary	Water quality and safety	Clean water and wastewater	Public	

Netherlands	Research, development, and innovation	Clean water and wastewater	Public	
Portugal	Asset management and planning (senior manager)	Clean water and wastewater	Public	X
UK	Risk management	Clean water and wastewater	Private	X
UK	Risk management (senior manager)	Clean water and wastewater	Public	X
UK	Asset management and planning	Clean water and wastewater	Private	X
UK	Climate change	Clean water and wastewater	Private	X
UK	Asset management and planning (senior manager)	Clean water and wastewater	Public	X
UK	Climate change	Clean water and wastewater	Private	X
US	Research, development, and innovation	Clean water and wastewater	Public	X
US	Strategic projects (senior manager)	Clean water and wastewater	Public	

US	Asset management and planning	Wastewater	Public	X
US	Asset management and planning	Clean water and wastewater	Public	X
US	Asset management and planning	Clean water and wastewater	Public	
US	Stakeholder outreach, asset management, and planning	Clean water	Public	
US	Asset management and planning	Clean water	Public	
US	Strategic projects	Wastewater	Public	
US	Climate change	Clean water and wastewater	Public	
US	Risk management	Clean water and wastewater	Public	
US	Public relations	Clean water and wastewater	Public	
US	Research, development, and innovation	Clean water and wastewater	Public	
US	Senior management	Clean water and wastewater	Public	

US	Climate change	Clean water and wastewater	Public	
----	----------------	-------------------------------	--------	--

The interviews attained ethical approval, and the anonymity of participants was preserved. The interviews were conducted between September 2019 and March 2020 on a one-to-one basis via telephone or Skype, and they ranged in length from 30 minutes to over 2 hours. All interviews were recorded and transcribed verbatim, with two interviews translated (from Portuguese to English) and transcribed by the researchers.

Transcripts were stored and organised in the software Nvivo TM 12 (QSR International Pty Ltd, 2020). Reflexive thematic analysis (Braun & Clarke, 2006) was employed as the analytical method due to its theoretical flexibility and potential to derive insightful patterns of meaning across the dataset. A predominantly inductive approach steered the creation of codes and themes that were regularly revisited across all transcripts. However, we also acknowledge that the literature review partly influenced the analysis of data and the creation of themes. The researchers were conscious about regularly reviewing themes to ensure a clear distinction between them and to certify that the themes devised were consistent across the data set to avoid recency bias. Codes and themes were devised based on patterns that had relevance and importance in clarifying the organisational environment of water utilities with respect to resilience, as opposed to the frequency of citation across the entire dataset (Braun and Clarke, 2006). We related the devised themes with the analytical framework on organisational resilience (Lengnick-Hall & Beck, 2005; Lengnick-Hall et al., 2011) to explore current organisational challenges and their respective implications for the water sector. The assessment of themes against the framework allowed a more comprehensive analysis within

different organisational dimensions (cognitive, behavioural, and contextual), thus clarifying the complexity of developing organisational properties conducive to resilience in a water utility environment.

2.3 Results

The results are structured based on the themes below (Table 2-3). This table relates the main themes derived from the thematic analysis with the analytical framework (Table 2-1). We assessed the themes against the most relevant organisational properties. This approach allowed the researchers to pinpoint challenges and their implications, thus providing an initial visualisation of where resilience solutions could be targeted in the organisational sphere.

Our results have shown that progress has been made toward embedding a deeper understanding of the importance of human elements in building resilience. However, in this paper, we focused our analysis on the challenges standing in the way of building the internal organisational properties that support organisational resilience.

Table 2-3: Identified themes and the implications for building organisational resilience, based on the theoretical framework from Lengnick-Hall and Beck (2005) and Lengnick-Hall et al. (2011).

Identified themes:	Implications to organisational resilience in water utilities:
Narrow understanding of resilience.	• Cognitive Interpretations of resilience are narrowly focused on risk management and robustness, with little consideration of flexibility

	and adaptability elements of resilience, thus limiting sense-making when managing shocks and stresses.
Justifying and sustaining resilience.	• Cognitive and behavioural Decreased capacity to read (sense-making) and respond to threats proactively due to dominant reactive and efficiency values that drive behaviour, thus restricting the development/ability to draw from behavioural reserves.
Constrained environment for innovation.	• Contextual and cognitive Lack of tangible and intangible resources to foster innovative and flexible values to drive creative solutions and experimentation toward organisational renewal and growth.
Resilience and resources.	• Contextual and behavioural Unfavourable contextual scenario due to resilience not being seen as a basic necessity, thus competing with other impending priorities and hindering the ability to manage paradoxical tensions. Insufficient resources and funding impact the range of behavioural reserves (well-rehearsed/ organic responses) to manage shocks and stresses.
Silos and conflicting priorities.	• Contextual and behavioural Lack of effective resource networks (interpersonal connections) and inclusive decision-making (diffuse power), thus leading to misaligned and duplicated organisational efforts.

Uncertainty on leadership buy-in.	• Contextual Absence of a driving force pushing the development of processes and allocation of tangible and intangible resources in support of organisational resilience.
Organisational structures.	• Cognitive Lack of a consistent cognitive frame (cultural identity) to ensure organisational-wide understanding and commitment to organisational resilience values.
Lack of understanding of how to embed a culture of organisational resilience.	• Cognitive and behavioural • Inadequate organisational values and beliefs and under-explored cultural characteristics that influence behaviour toward organisational resilience, thus impacting a cohesive cultural identity and commitment to the organisational vision.

2.3.1 Narrow understanding of resilience

The findings denote a narrow perception of resilience, as some participants rarely related resilience with more flexible concepts such as adaptability and flexibility. Instead, some participants articulated their views on resilience based on more confined concepts such as risk management and engineering robustness. However, resilience is a broader concept composed of multiple interventions underpinned by different (and potentially contrasting) concepts, as unilateral and rigid cognitive lenses are insufficient to build organisational resilience. In addition to this narrow understanding, the results also showed some confusion around the general concept of resilience, which was manifest predominantly by participants from non-

English speaking countries, with one noting: *“There is no exact word in [my language] that exceeds this concept. We use the English word, ‘resilience’ [...] I think we still ha[ve] difficulties understanding the complete concept” (WA01).*

2.3.2 Justifying and sustaining resilience

The challenge of justifying resilience to the organisation was related to perceived non-tangible benefits, the frequency of extreme events and resilience being pitched internally based on hypothetical scenarios: *“I think it’s really hard to engage people who have never been in a disaster, or who don’t really have the sense of what a disaster and chaos looks like” (RI10).* However, the need for resilience was often acknowledged only after a crisis. Sustaining resilience investments in organisations ‘presumed’ to have high levels of resilience maturity was also seen as a major challenge: *“[...] over the past years [...] the government and others see us like we are okay. The things we do to keep up with this level of resilience sometimes are regarded – this is really ironic – are regarded as needless” (RI13).* This efficiency-driven and reactive stance instils brittleness in the ability of water utilities to read effectively and proactively (sense-making) and respond to potential threats, which are essential cognitive and behavioural properties of organisational resilience.

2.3.3 Constrained environment for innovation

Innovative advancements drive organisations to improve their expertise and practice and support dynamic responses. However, the findings suggested that uncertainty and scarce resources often inhibited the implementation of innovative efforts: *“When you're in a very financially constrained operating environment, it can be really difficult to make the case for doing something different when you don't know whether it's going to work [...]” (RI02).* There was a degree of caution about implementing untested solutions, such as green infrastructure,

in the context of highly constrained resources with the pressure of sustaining the delivery of what were deemed to be more reliable services.

Additionally, reluctance to change by individuals in the organisation was seen as a barrier to innovation and professional development. Attaining a mindset that embraces change amongst personnel was a dominant issue that was sometimes influenced by fear and unwillingness to experiment with novel approaches: *“If something always worked [...] there's really no benefit to the individual to encompass change. Whereas it might be a huge benefit to the organisation, the risk to themselves might be weighed as greater than their desire to move forward”* (RI23B).

2.3.4 Resilience and resources

Most participants noted that scarce resources and financial limitations hindered proactive behaviour that favoured long-term benefits: *“[...] there's a particular challenge that we're facing in this moment in time around our ability to invest in what we need to do to maintain, or to improve our performance to meet expectations versus the financeability of water companies [...]”* (RI03). Additionally, some participants perceived resilience initiatives not as a basic necessity.

Although lack of resources was a challenge expressed by most participants, middle-income countries were particularly vocal about how deficiencies in the quality of water services and scarce resources impacted their ability to initiate resilience efforts. Therefore, adopting resilience under conditions of scarce and coveted resources was perceived as unnatural due to the need to address other priorities: *“So this topic of resilience, I believe that water utilities [here] they know the importance of it, but given that we have more essential and basic problems [...], I believe that for other water utilities [...] this concept is not such a huge*

priority at the moment” (RI19). This scenario of scarce resources is problematic because organisational resources support contextual conditions to enact cognitive and behavioural properties of organisational resilience.

Further, participants emphasized financial issues, which were associated with the following factors: (1) societal desire to maintain water prices as low as possible; (2) decreasing demand and revenue due to population/consumption decline; and (3) lack of funding. From the perspective of private utilities, the participants underscored a misalignment between water price determinations by regulators and the long-term resilience needs of utilities: “[...] *most water companies ha[d] to put back to the regulators [...]: 'We can't do what you're asking us to do with the amount of money that you're allowing us. It's not possible. It makes us unfinanceable as a business'*” (RI02). Elsewhere, some public utilities reinforced resilience concerns associated with lack of funding due to competition for funds with other sectors: “[...] *Resiliency funds would be competing with homelessness funds, with public health funds, with trash funds, even with improving water supply funds. When you look from that perspective, is it right to fund resiliency when you have a lot of people homeless on the street?*” (RI21). Still in the public sphere, some notable yet niche remarks were also made around water tariffs being frozen centrally by the government for a prolonged period, the commission of resilience initiatives “on paper” without governmental funding and dilapidation of infrastructure due to a lack of maintenance funds to ensure its resilience.

2.3.5 Silos and conflicting priorities

Participants voiced that reaching out to others to assemble more comprehensive solutions beyond their silos was often not supported. The lack of integration impacted effective communication and cohesive information management, where independent and isolated

solutions generated unintended and harmful consequences across the organisation. For instance, addressing immediate urgencies within one silo may cause detrimental impacts on different parts of the organisation: *“One of the challenges is that the person here may do something which has made their life easier. They’ve achieved what they want to achieve. But actually, they’ve made it difficult for the business over here because there’s a cascade effect (RI06.1)”*. Lack of integration and cohesiveness in water utilities was seen as a challenge that could lead to unnecessarily duplicative work.

Sharing information through collaborative integration and resource networks supports the growth and diversity of intellectual capital and increases awareness of interdependencies amongst different silos in the organisation, thus preventing rework and streamlining organisational processes. However, based on the data in this study, we identified three main silos that may lead to conflicting priorities and lack of cohesion within water utilities: (1) physical characteristics, (2) technical background, and (3) hierarchical levels.

2.3.5.1 Physical characteristics

The physical characteristics of water utilities were noted siloed: *“[the] company is very big because it serves the whole state. [...] So, within our organisation there is a great difference according to different regions” (RI19)*. Some participants recognised that water utilities suffer from compartmentalisation due to their large size and the physical separation of workplaces: *“I think part of it is that we have physical separation between some of our places – our workplaces, right?” (RI06)*. It was highlighted that disseminating information across the whole organisation can be difficult, as in some cases, staff do not have e-mail addresses and have different work patterns.

2.3.5.2 Technical background.

In an environment such as a water utility with highly specialised personnel who are deeply immersed in their own technical mindset, understanding the complementary or conflicting priorities of others' work was perceived as difficult. This divide led to technical silos, as described by a participant:

“[...] the scaler team and the modelling team ended up having a little bit of an argument with the folks in the field. The folks in the field basically were saying, ‘This is what we are seeing out in the field. [...] We don’t care what you are doing sitting in your cushy cabins and running computer models’” (RII1).

Participants also highlighted the need for different professions and departments within utilities to be open to working collaboratively together for more comprehensive solutions.

2.3.5.3 Hierarchical levels

The final contributor to a siloed behaviour within water utilities was the divergent priorities and objectives of different hierarchical levels, as pointed out by the following:

“The reason sometimes they don’t see eye-to-eye is because we’ve not taken the time organizationally in connecting [...] the people who work on these physical assets in the field to the people who actually plan and develop long-term capital infrastructure plans for the future” (RII1).

Participants pointed out a misalignment of objectives between (senior) management and some parts of the organisation, which led to contrasting understandings of the impending organisational needs. Fostering integration was seen as a way for individuals to improve their understanding of the real needs and priorities of the organisation.

2.3.6 Uncertainty on leadership buy-in

The endorsement of resilience efforts by senior management was a topic voiced by the participants. It was underscored that leaders need to understand the importance of resilience and resilience investments. However, some participants expressed a degree of uncertainty as to whether senior managers' priorities were consistent with the resilience priorities of the organisation *"I think they are also driven by their personal liability, so perhaps it's interesting to see what a typical director sees as important in this topic [...]" (RI08)*.

Participants, mostly from public water utilities, underscored the issue regarding short-term strategies that do not necessarily contribute to resilience: *"As cycles change administratively, if there is no unified framework then it's only a matter of [...] the next government or the next leadership bringing their own understanding of what resilience or enterprise resilience means"* (RI11). Some also questioned the appropriateness of Board members' objectives, highlighting that they could be influenced by personal liability or political pressures. This situation is problematic because the goals set by leaders steer the collective behaviour of individuals and shape organisational culture, thereby influencing the ability to build organisational resilience.

2.3.7 Organisational structures

Participants emphasized the importance of centralised organisational structures to enhance integration and embed resilience principles across the organisation. A dominant topic was the need for a centralised department or a champion that drives resilience properties and assembles organisational linkages: *"One is again having the centralised group. It's a small team, but they're there to help you sort of how to interpret and facilitate and moderate the discussions that we do"* (RI09). Accordingly, some participants perceived centralised

structures as key to progress with the resilience agenda as they can ensure a sustained organisational commitment.

The need for centralised resilience structures was reinforced by the disadvantages highlighted by a lack of an allocated role/department to deal just with matters related to risk management: *“If you look in the water space itself, [we are] one of the few utilities that actually has the position of a risk manager. A lot of people have that position with something else, so it doesn't get the focus that it does here” (RI23.B)*. A centralised group or role was viewed as bringing focus to coordinating and sustaining resilience strategies within water utilities without getting replaced by other impending matters.

2.3.8 Lack of understanding of how to embed a culture of organisational resilience

Organisational culture was a prevalent subject. However, descriptions of how to implement changes to drive a culture conducive to organisational resilience within water utilities were often vague. Instead, the many remarks about culture were associated with a need to change and recreate the current organisational culture: *“I'm just going to give you one word; culture. The culture in organisations is fundamental to change. Looking at my organisation, our culture needs to change” (RI07)*.

Interviewees associated organisational culture with values that shape behaviour. In addition, some participants indicated that the organisational culture should be set and shaped by leaders. Others also highlighted that organisational policies and structures could also shape a culture of resilience. Some noted that a positive culture change might be brought about and leveraged after a crisis.

While ‘culture’ was vaguely described, some attributes were commonly cited and associated with a culture that contributes to organisational resilience: (1) empowerment, (2) trust, (3)

sense of pride and (4) integration and collaboration. The empowerment attribute was characterised as the ability to empower individuals to ‘speak up’ about any issues or errors. A culture of trust was seen as creating psychological safety through a supportive and ‘no-blame’ environment for personnel. A sense of pride was described as motivating employees to be enthusiastic about their role in contributing to the broader organisational vision and objectives. Finally, integration and collaboration were perceived as establishing a culture that embraces the infusion of different perspectives and backgrounds in organisational practices.

2.4 Discussion

Organisational resilience in CIS is often analysed as an assessment against a set of principles (Brown et al., 2017; Sweya et al., 2020), described through prescriptive and attribute-based resources (Denyer, 2017; ResOrgs, 2012), with few empirical studies examining in-depth the organisational environment (Gover & Duxbury, 2018), especially in water utilities. This research builds upon existing resources by investigating the organisational environment of water utilities. We related the themes observed to an analytical framework (Lengnick-Hall & Beck, 2005; Lengnick-Hall et al., 2011) to support a better understanding of the challenges standing in the way of organisational resilience in the water sector. We assert that the operational realities in water utilities can create challenges to building organisational properties conducive to organisational resilience. The empirical approach and broad scope allowed us to identify key challenges to building organisational resilience from cognitive, behavioural, and contextual properties, thus illuminating the complexity of embedding organisational resilience in water utilities. The novel international scope of this research reveals how different regional contexts manage the resilience needs for the future within the daily pressures of a utility environment.

2.4.1 Clarifying resilience to practitioners

The interpretations of resilience by the participants centred on risk management and robustness, with little consideration of other aspects of resilience, such as flexibility and adaptability. This stability-centred view encompassed fail-safe values (Rodríguez et al., 2020) attached to tried and tested procedures without much reflection on the cognitive dynamism required to manage unprecedented events (Chester & Allenby, 2019). This view also contrasts with the flexibility capability in the cognitive property posited by Lengnick-Hall et al. (2011) that supports enhanced sense-making of events and the environment.

Robustness and risk management were often associated with resilience, as they have traditionally been the basis of infrastructure planning (Crick & Bentley, 2020); however, this narrow perception limits the construction of other, equally important, resilience-cognitive capabilities that support the identification of effective solutions through enhanced sense-making.

Narrow interpretations of resilience may impact practice (Moser et al., 2019), influence culture and thus hinder the capacity to build organisational resilience. Further, participants in this study occupy roles of at least the managerial level and have strategic influence in organisations; an incomplete understanding of resilience may thus cascade down to personnel and influence organisational beliefs and behaviour (Lengnick-Hall et al., 2011; Summerill et al., 2010).

This finding indicates a real need to broaden current thinking on resilience to account not only for conventional fail-safe approaches (Rodríguez et al., 2020) but also for concepts that embody more flexible and dynamic notions in the cognitive frame of the organisation (Lengnick-Hall et al., 2011). A more comprehensive interpretation of the concept across the

organisation may support expanding sense-making capabilities, thus enhancing personnel preparedness.

2.4.2 Embracing paradoxical thinking

The pressures water utilities face, such as a lack of funding, efficiency demands, and increased costs (Chester & Allenby, 2019), were recognised as conflicting with resilience initiatives. Resources are not only contextual enablers of organisational resilience (Lengnick-Hall et al., 2011), but they enhance resilience efforts during and after a crisis (Gittell et al., 2006). The overall sentiment was that investing in resilience entails increasingly constrained resources and, as cited by the participants, often results in intangible outputs.

If the dominant notion of resilience in water utilities revolves around efficiency and reacting to short-term issues (Chester & Allenby, 2019), water utilities may not actively manage tensions through paradoxical thinking. Paradoxical thinking is the ability to manage the trade-offs of contrasting behaviours, such as being open to experimentation while sustaining the reliability of systems, and is one of the main behavioural capabilities of organisational resilience (Denyer, 2017; Lengnick-Hall et al., 2011). Currently, the efficiency-driven cognitive and behavioural properties mean that water utilities may not have the ability to develop other capabilities such as flexibility and adaptability, thus limiting their ability to expand their behavioural reserves. Embracing paradoxical thinking can accommodate the efficiency and resilience needs in water utilities. Future research should seek to understand potential pathways that support paradoxical thinking and drive such capabilities within the operational realities of water utilities and constrained resources.

Similarly, barriers to innovation stemmed from the organisational context of scarce resources, risk-averse values, and the behavioural reluctance to experiment in terms of technological and

personnel development. As highlighted by some participants, resource constraints and the tendency of the industry to prevent risks by focusing on tried and tested approaches (Baehler & Biddle, 2018; Chester & Allenby, 2019; Crick & Bentley, 2020) hinder the ability to experiment with novel solutions. From the perspective of the workforce, pitching for renewal and challenging old assumptions was voiced to be blocked by a mentality of “more of the same”. This mentality reinforces the challenges and the complexity in managing the tensions attached to organisational resilience (Denyer, 2017), such as innovation and reliability (Biddle & Baehler, 2019), particularly due to the need to devote tangible and intangible resources to promote acceptance and buy-in of an innovative cognitive frame.

Solutions could be fomented by allocating activities for innovation outside the daily pressures of service delivery (Baehler & Biddle, 2018), leadership encouraging new approaches (Mafabi et al., 2015) and the development of a safe environment to encourage creativity amongst the workforce (Denyer, 2017). Shaping human capital for experimentation and creativity could bring opportunities for water utilities to prevent a predominance of path-dependent outcomes (Crick & Bentley, 2020) and develop new capabilities and expertise to deal with emerging events (Lengnick-Hall et al., 2011). We suggest that deeper approaches may also be needed that target the current context in water utilities (resources and processes) to encourage cognitive and behavioural characteristics that stimulate innovation and growth of different organisational assets; human and built capital.

2.4.3 Bridging silos

Silos were noted by participants from all different regions, utility types and scopes, thus reinforcing siloed working as a significant organisational resilience challenge (Brown et al., 2017; Crick & Bentley, 2020). Therefore, some utilities may find it challenging to build

internally social capital and strong resource networks to undertake coordinated actions to advance resilience goals across the organisation (Lengnick-Hall et al., 2011). Furthermore, duplicated work compounds a utility's ability to optimally leverage increasingly scarce resources to employ resilience.

Despite not being mentioned in the literature, physical characteristics such as assets and offices dispersed across large areas were perceived as contributors to isolated actions and a lack of effective communication. Further, environments containing individuals with highly specialised backgrounds may struggle to conciliate different views of a problem, generating misunderstandings and limiting the individuals' ability to interpret different mind frames (Timmerman & Langaas, 2005). Finally, different hierarchical levels have distinct priorities (Macrae, 2019), which may cause disagreement in prioritising organisational needs. Operational personnel are more focused on specified resilience efforts (e.g., the resilience of what to what). The relevance of general resilience (e.g., organisational-wide capacity to manage threats) as an organisational strategy increases at higher levels of the organisation (Macrae, 2019; van der Merwe et al., 2018).

The different categories of silos identified may require a more targeted approach that addresses different types of silos, hence going beyond proposed solutions in current literature. Creating an inclusive environment (Crick & Bentley, 2020) through leadership, organisational values (Gibson & Tarrant, 2010), and sharing of knowledge (Chester & Allenby, 2019) may be too unspecific to bridge different categories of silos. We argue that future research should identify ways to pragmatically employ measures that specifically target physical, technical, and hierarchical silos and advance understanding of their linkages in these organisations to promote strong networks of diffuse power to facilitate internal social capital. By bridging

silos, a context of positive interpersonal relationships and inclusiveness develops to support organisational knowledge growth, collaboration, and cohesion (Lengnick-Hall et al., 2011).

2.4.4 Attaining leadership support

The participants indicated some degree of uncertainty regarding support from leadership on resilience. Public utilities flagged concerns about short-term strategies due to political cycles or personal liability. This scenario indicates a lack of tangible and explicit resilience commitment from leadership. Hence political agendas and short-sighted priorities can be detrimental and restrict a utility's ability to implement and sustain long-term resilience initiatives (Baehler & Biddle, 2018). Some studies highlight the importance of leadership as an organisational resilience driver (Denyer, 2017; Gover & Duxbury, 2018), especially as leaders steer strategic priorities for the organisation (Gibson & Tarrant, 2010) and are critical in setting the organisational culture (Baker et al., 2018; Taylor et al., 2017), thus underscoring the contextual significance of leadership support for organisational resilience. However, it is unclear how senior leaders view resilience and are motivated to support resilience in these organisations. As identified above, utility managers may have a narrow understanding of resilience influenced by fail-safe approaches, thus impacting the development of organisational resilience properties in water utilities. Therefore, clarity is needed on how senior managers view resilience and how political and personal variables impact legitimate resilience endorsement by leaders. Further work should focus on identifying the drivers that influence senior leaders' stance relative to resilience and how resilience strategies can transcend political cycles in the context of public utilities.

Furthermore, the findings indicate that utilities with different contexts and ownership arrangements are trying to accommodate their resilience needs in a financially constrained environment. For privately owned utility monopolies, regulators' stringent water price

determination derives from the need to protect ratepayers (Pawsey et al., 2018). The lack of funds in the public sector was more strongly influenced by political pressures related to the short-term satisfaction of the electorate (Baehler & Biddle, 2018). We argue that fundamentally the financial limitations - from either private or public perspectives – derive from motivations to protect water customers from bearing the brunt and its potential political repercussions. Therefore, the water sector may experience financial limitations more acutely due to its monopoly nature and political sensitivity, thus reinforcing the need to attain socio-political will and support for the resilience of water utilities.

Further, we acknowledge the complex socio-political implications and considerable limitations of embedding resilience elements, such as proactively managing low-probability/high-impact events, to the affordability of water services (Decker, 2018). Nevertheless, our findings indicate that water price determinations from the regulatory and political spheres do not reflect the realities of short and long-term resilience needs of water utilities from diverse backgrounds. Therefore, given the complexity of managing water sector resilience and ensuring affordability to customers going forward, the findings shed light on the relevance of building external contextual capabilities of social capital through customer engagement to advance understanding of resilience needs and customer preferences toward establishing appropriate water prices (Ofwat, 2016). Future work should focus on assessing the relationship of how enhanced customer engagement or more inclusive modes of governance may support, specifically, the legitimisation of the resilience needs of the water sector.

2.4.5 Configuring organisational structures

As opposed to risk management, which has well-defined structures within organisations (Mauelshagen et al., 2016), little is known about how organisational resilience structures

should be positioned within water utilities. Whilst the participants manifested a need for centralised organisational resilience structures, our research suggests that structures that support organisational resilience are disperse and remain at their initial stages. However, the participants desire for concentrated organisational resilience structures, contrasts with previous views that resilience should be ingrained in the ‘bloodstream’ of organisations and spread as an organisational-wide commitment instead of being the responsibility of one specific individual or group (Denyer, 2017; van der Merwe et al., 2018). Responses from interviewees suggest that the absence of centralised structures may hinder the ability of a utility to ensure a sustained cultural commitment and accountability (Lengnick-Hall et al., 2011) for organisational resilience. Nevertheless, we argue that an overly centralised approach may also detract from building a widespread culture conducive to organisational resilience.

We posit that a balance is needed between fostering a utility-wide resilience commitment and allocating roles with the sole responsibility of driving and sustaining organisational resilience, as both approaches bring benefits and merit experimentation. Therefore, there is a need to improve understanding of how centralised resilience structures should be positioned in water utilities while also ensuring organisational resilience commitment across different levels and departments.

2.4.6 Need to unpack a culture of organisational resilience

Although culture was not explicit in the interview topic guide, the findings denoted a need for an organisational culture change in the water sector, aligned with Baker et al. (2018) and Smith et al. (2019). Given the prominence of culture in our findings and theory (Baker et al., 2018; Gibson & Tarrant, 2010; Gover & Duxbury, 2018; Hamel & Valikangas, 2003;

ResOrgs, 2012; Sheffi & Rice, 2005; Taylor et al., 2017) we argue that culture is a key element of organisational resilience in water utilities (Summerill et al., 2010).

However, the analysis indicates a vague understanding of how to effectively drive a culture in support of organisational resilience within the context of water utilities, as previously flagged by Smith et al. (2019) and Sweya et al. (2020). Similar to theoretical resources (Gibson & Tarrant, 2010; ResOrgs, 2012; Taylor et al., 2017), some participants indicated that an organisational resilience culture should be set and shaped by leaders or can be brought about after a crisis. Despite the above factors, detailed information on building a culture conducive to organisational resilience for the water sector is lacking in theory and practice (Duchek, 2020; van der Merwe et al., 2018).

Consistent with prior research, our findings identified cultural attributes that were cited as beneficial cultural characteristics, including empowerment (Denyer, 2017; Sheffi & Rice, 2005), trust (Gibson & Tarrant, 2010), sense of pride (Mafabi et al., 2015) and integration and collaboration (Crick & Bentley, 2020). Although these attributes have been previously mentioned in literature and are not unique to the water sector, they are often cited individually without an in-depth account of their potential complementarity. This novel grouping of attributes presents a starting point for developing a cultural framework that accounts for the relationship of different cultural characteristics that support organisational resilience in water utilities.

Through the joined values and beliefs of individuals (Gover & Duxbury, 2018), the organisational culture forms part of the cognitive property of organisational resilience that shapes behaviour (Lengnick-Hall et al., 2011). Therefore, the themes and challenges identified across this paper - narrow understanding of resilience, difficulties in managing

paradoxical tensions and leadership buy-in, for example - may be heavily influenced by the current culture shared and articulated by individuals in water utilities. However, given that 'culture' was not the main focus of this study, the validity of the above statement needs to be further explored through future research. Clarifying the links between current culture and behaviour and further demarcating cultural attributes conducive to organisational resilience will provide new insights into effective organisational resilience strategies for water utilities.

2.5 Limitations

This international study delivers a modest snapshot of different contextual realities. Therefore, our findings do not translate as generalizable illustrations of the participating countries. We also acknowledge that the involvement of some project steering group members in the interview study can be a potential source of bias. However, we aimed to minimise this issue by actively recruiting interviewees from outside the project working group. We are also cognizant of the discrepancy in the number of participants per region; therefore, we were conscious to not base the creation of themes simply on the frequency of mentions, which could have skewed the results toward a single country. Instead, we focused on the depth of themes and representation of all regions in the identified themes. Lastly, we recognise that the views of resilience identified here reflect the perceptions of middle and senior managers in water utilities. Therefore, additional research is needed to uncover the views of frontline personnel.

2.6 Conclusions

The chief contribution of this study stems from showcasing, in detail, the challenges to building resilience in the cognitive, behavioural, and contextual organisational properties of water utilities. As observed, water utilities experience operational pressures and constraints

that may obstruct their ability to build and sustain organisational properties conducive to resilience. In this sense, even though the water sector seeks resilience generally, related principles may not be reflected in the organisational properties that allow organisational resilience to emerge (Lengnick-Hall et al., 2011). This study thus corroborates previous findings that the human elements of resilience are often overlooked by the water sector (Naderpajouh et al., 2018; Smith et al., 2019).

We argue that challenges to building resilience were more significantly related to cognitive and contextual properties, signifying that the challenges identified are deep-rooted in the foundations of utilities. For instance, the cognitive property is composed of values and beliefs that underpin the organisational culture, which is tightly tied with organisational behaviour, while the capabilities of the contextual property serve as a conduit to a resilience cognitive frame and behaviour (Lengnick-Hall et al., 2011). Tellingly, the behavioural property was influenced by challenges derived from cognitive and contextual dimensions, as opposed to being the source of challenges to other organisational properties.

From the perspective of the cognitive property, the firmly embedded views on fail-safe values were observed to over-shadow the cognitive flexibility needed toward a well-tuned and refined sense-making of potential threats. Similarly, inherent values of efficiency and reactivity due to resource constraints also may hinder the cultivation of a cognitive frame driven by innovation and experimentation. Lack of commitment and accountability to resilience values flagged the need to drive a consistent cultural identity of resilience in water utilities. Further, an original question was brought to light as to whether the responsibility of organisational resilience should be centralised or dispersed in water utilities. The findings noted that resilience interventions may not get equal priority as daily operational matters and

can be often diluted, hence the need for centralised resilience structures to reinforce a resilience-cognitive frame and drive a consistent cultural identity across the organisation.

Another significant shortcoming pertaining to the cognitive property was the uncertainty of the cultural attributes needed to drive an organisational culture in support of resilience. Our findings have added a novel dimension by grouping a set of key cultural attributes and reinforcing an appetite for a water sector culture change. Future research is needed on how to frame organisational values in water utilities in relation to organisational resilience and empirically investigate how culture impacts the organisational behaviour of water utilities.

In the behavioural property, the need to expand behavioural reserves to enhance preparedness was heavily limited by dominant values of efficiency and reactivity, as well as a lack of tangible and intangible resources. To reinforce such assertion, we drew from our analysis that utilities may not have the ability to effectively manage paradoxical behaviours, an actionable element of organisational resilience.

Contextual challenges ranged from lack of tangible and intangible resources to weakened resource networks and interpersonal connections due to silos. For instance, the development of social capital in utilities through contextual properties of diffuse power and positive resource networks was seen as significantly hindered by silos. As a novel contribution, we added depth to the current understanding of how silos exist in the water sector by structuring sources of silos into three different categories: (1) physical structures, (2) technical expertise, and (3) hierarchical levels.

Another key contextual challenge was the uncertainty of leadership buy-in on resilience efforts. This challenge mainly stemmed from factors related to short-term strategies due to political cycles or personal liability. In addition, a set of challenges more acutely felt by the

water sector, compared to other utility sectors, was the context of a financially constrained environment due to stringent regulatory price determinations and political pressures to keep bills low to avoid displeasing the electorate. This context emphasized establishing positive socio-political resource networks, especially through enhanced customer engagement and buy-in to legitimise inter-institutional changes toward resilience.

3 How do international water utilities perceive the role of customers in building the resilience of water services?

Abstract:

Although customer engagement has been recognised to support the resilience of the water sector, research has under-explored the views from utilities' managers on the roles customers could play in building water sector resilience. Here we focus on the contextual property of organisational resilience - based on external relationships. This study evidences a narrative change from literature by acknowledging the need to leverage customers as being active agents alongside water utilities to better manage disruptions and sustain resilience. Although it was recognised a role as 'passive beneficiaries' of resilience, positive roles were also identified, such as facilitators of more targeted initiatives, contributors to higher tolerance levels and positive behaviour-change, and resilience advocates. However, leveraging the positive roles may require meaningful engagement that accounts for the different needs and priorities of a variety of customer segments. We have identified a set of engagement interventions that serve as an initial step towards maximising the positive role customers could play in building resilience.

3.1 Introduction

The concept of resilience has been widely promoted as a guiding principle to support decision-making and practice in the water sector (Lawson et al, 2020; Ofwat, 2017). This is because water utilities must rise to novel challenges stemming from the increasing occurrence of acute events (such as sudden flooding) as well as chronic and gestational disturbances derived from population growth and urbanisation. Managing the complexity of present and upcoming challenges may require water utilities to adopt broader and novel solutions by tapping into

behaviour and culture of personnel as well as engagement and collaboration of wider stakeholders (Reed et al., 2018) as opposed to relying on conventional isolated and mechanistic approaches (Pahl-Wostl, 2009).

Recent resilience studies have emphasised a need to expand resilience capabilities by advancing initiatives focused in the social and organisational domains (Lawson et al., 2020; Smith et al., 2019). Broader capabilities for more comprehensive solutions - that go beyond the strict confines of water utilities - are required to build, and maintain the resilience of water services (Giffoni et al., 2022; Ofwat, 2017).

3.1.1 Customer engagement and resilience

Customer engagement is recognised as a key process that supports effective decision and policy making of critical services (Hendry, 2016; Sayles et al., 2021) and has been noted to support the resilience of the water sector (Baehler & Biddle, 2018; Baker et al., 2018; Crick & Bentley, 2020; Ofwat, 2017). For instance, customer engagement may incentivise behaviour change towards conservation (Pawsey et al., 2018), it can educate the public on the adequate utilisation of infrastructure to minimise failures (Tepes & Neumann, 2020), facilitate effective communication in times of crisis for swift recovery (Petersen et al., 2020), and foster alignment of expectations and needs between utilities and customers (Biddle & Baehler, 2019; Ofwat, 2016). In addition, benefits such as positive reputation, customer support, awareness-raising, transparency, and enhanced quality of services can result from proactive customer engagement (Dziedzic & Karney, 2016; Littlechild, 2014).

Although difficult to achieve effectively, as it entails time and resources of all parties involved (Hendry, 2016), customer engagement is emerging as a crucial step in acquiring public

support and sponsorship of initiatives that contribute to the present and future resilience needs of water utilities (Baehler & Biddle, 2018; EUM, 2017; Hendry, 2016; UKWIR, 2017).

Some governmental entities recognise the importance of customer engagement and are strongly encouraging as well as mandating water utilities to proactively delve into the needs and priorities of customers to gain buy-in and steer decisions democratically (Hendry, 2016; Ofwat, 2017; Pawsey et al., 2018; EPA, 2017). Countries such as the UK, Australia and the US have relatively developed frameworks and initiatives on customer engagement for the water sector (Ofwat, 2017; EPA, 2017; Ananda et al., 2022; Biddle & Baehler, 2019; Lawson et al., 2020).

The prominence of discussions for greater customer engagement derives from perspectives on protecting customers of the monopoly-based nature of water utilities, through inclusion and participation, to agree on solutions to rising challenges impacting water services' functionality. This, therefore, has unlocked an ongoing debate: "To what extent customers' needs and preferences should be reflected in the resilience planning and investments of water utilities?" (Decker, 2018; Hendry, 2016; Pawsey et al., 2018).

Conversely, studies have also highlighted some challenges to effective customer engagement. For instance, tokenistic participation, resource constraints (Pomeranz et al., 2014), communication overload (Heino & Anttiroiko, 2016), overly complex and technical language (Hendry, 2016) and a lack of fair cross-representation of different public segments (Marshall & Jones, 2005; Thaler & Levin-Keitel, 2016) are some of the challenges previously flagged. In addition, unclear and poorly designed engagement initiatives with the public may lead to a lack of trust and damaged reputation (Akhmouch & Clavreul, 2016), thus highlighting its sensitive nature.

3.1.2 Exploring customers' roles in building resilience

Despite conflicting perspectives on the advantages of customer engagement (Reed et al., 2018), a heavily under-explored area of relevance is the role of customers in the resilience of water services and how to facilitate and optimise positive roles for resilience. Even though the literature indicates that customer engagement is a positive endeavour for resilience (Golladay et al., 2020; Ofwat, 2017; Wallis-Lage, 2015), it fails to articulate in detail the potential roles customers could play alongside water utilities. Capturing a variety of customers' roles can support the identification of resilience-boosting roles that should be maximised, or roles that may increase the vulnerability of water services. For instance, Giffoni et al., 2022 (chapter 2) noted that customers could support the legitimisation of appropriately funding for the resilience needs of the water sector.

The researchers' interest in this area is underpinned by the tight interdependency between humans and physical infrastructure resilience (Doorn et al., 2019), which underscores the need to develop integrative capabilities that also cover domains beyond the physical boundaries of utilities.

This interdependency, from a top-down perspective, relates to the continuous delivery of water services which supports prosperity and resilience of wider society, given that such services greatly underpin social and economic development. From a bottom-up viewpoint, humans can adjust their behaviour and develop agency to provide effective sentience towards infrastructure resilience. Therefore, the ability of customers to better tolerate disruptions may translate as a coping capacity that may prevent the exhaustion of recovery capabilities (Balaei et al., 2019a; Petersen et al., 2020), and behaviour-change can be manifested as reduced depletion of natural resources.

In this paper we draw from the concept of Organisational Resilience (OR), which is the collective ability to absorb, adapt and capitalise from shocks and stresses (Lengnick-Hall et al., 2011). More specifically, here we focus on the external social domain by building on the contextual property of OR – positive relationships and social networks fomented outside the boundaries of water utilities. As such, a contextual property conducive to OR is observed through social interactions that support the development of social capital, diffuse power, psychological safety, broad resource networks, and tangible and intangible resources (Lengnick-Hall & Beck, 2005; Lengnick-Hall et al., 2011). Therefore, the process of leveraging and maximising positive customers' roles in building wider water sector resilience is itself an important property of OR.

In relation to OR, building social networks with customers is a crucial contextual property to deliver appropriate responses to manage complexity (Lengnick-Hall, et al 2011). Across different critical infrastructure sectors, specific roles have been identified as contributors of OR. For instance, in the UK, customers served as sounding boards to steer the business plans of natural gas companies. The input from customers diversified perspectives and instigated new approaches which led to an expansion of customers' roles from just setting internally monetizable objectives towards additional qualitative social and environmental targets (Poulter & Bolton, 2023). Elsewhere, Gonçalves & Patrício (2022) elaborated on the various co-creation roles customers could play in collaboration with smart energy services, such as positive behaviour-change and as accountable agents in the transition from traditional to new smart-meter services.

Similarly, some crucial customers roles have been identified in the water sector in the UK, such as contributors to the debate towards in fair price-setting of water tariffs, representatives of the preferences of wider customer segments, and collaborators in steering business plans

(Heims & Lodge, 2017). However, the links between the role customers could play and OR are not well understood. Underpinned by the contextual property of OR (chapter 2: table 2-1), we explore the perceptions of water utilities' leaders to clarify the following line of enquiry: *'How do international water utilities perceive the role of customers in the resilience of water services?'*. Given that water managers experience the daily organisational challenges of delivering sustained services, capturing the roles of customers from their perspectives can broaden understanding on the links between customers roles and OR. Through semi-structured interviews with water utility managers, this paper provides some clarity on the role of customers in the resilience of water services and identify ways to facilitate and optimise positive collaboration.

3.2 Methods

This study was conducted as part of a wider research project produced (see Giffoni et al., 2022 for further details) and the methods utilised here mirror the ones in chapter 2, however underpinned by a different research question. Semi-structured interviews were conducted with representatives of water utilities from Australia, Brazil, Canada, East Asia, Greece, Hungary, Netherlands, Portugal, UK, and US, thus containing a scope of middle and high-income countries with well-institutionalised water utility services. This choice of method enabled the researcher to elicit in-depth perceptions from utilities' managers, whilst following a structured questionnaire that guided the breadth of topics discussed (Adams, 2010). The interviews aimed to draw out the realities of international water utilities and, specifically for this study, they explored the contextual properties of OR which encompassed the external relationships with customers.

An interview topic guide was devised which provided a framework for which to probe the contextual property of water utilities in relation to the external interactions with customers. The topic guide was further refined through two pilot interviews with representatives from water utilities. The topics covered the participants' perceptions on the general resilience concept, the organisational environment of water utilities and the engagement with external stakeholders.

The recruited participants were managers and senior managers within the participating utilities. Our sample had a total of 31 water utilities' representatives, of which 13 were purposively invited to take part given their active involvement in the steering group of the US Water Research Foundation project which funded this research (see further details in Acknowledgments). However, with the intention to diversify our sample an additional 18 representatives, that had no association with the project steering group, also took part in this research. They were selected based on their ability to influence the resilience decision-making of water utilities and experience in a utility environment. Two participants representing a Water Association from East Asia had their country of origin omitted to ensure their anonymity. The characteristics of the participants in this study were extracted from Giffoni et al., (2022) (chapter 2 of this thesis).

Anonymity of participants was preserved throughout the research and the interviews were granted ethical approval. All the interviews took place from September 2019 to March 2020, ranged in duration from 30 minutes to over 2 hours and were conducted through telephone or Skype. Each interview was recorded and transcribed verbatim. Two interviews were transcribed and translated (Portuguese to English) by the researchers. Lastly, the data was kept and organised in the Nvivo TM 12 software (QSR International Pty Ltd, 2020).

The analysis of the data set was carried out inductively underpinned by reflexive thematic analysis, as outlined by Braun & Clarke, (2006), which was employed given its fluidity of application to different theoretical frameworks and capacity to probe and disclose underlying patterns of meaning. The themes, which were frequently reviewed to ensure singularity, and evolved from superficial descriptions of different groups of codes (semantic) to underlying conceptualisations of a specific issue (latent). The creation of codes and themes was steered by the research questions, thus generating patterns of meaning that clarified the perceptions of the customers' role in building resilience for the water sector and ways to facilitate and harness positive outcomes.

Table 3-1: Evidence table illustrating the themes, sub-themes, participants' quotes, and the number of respondents whose transcript contains the respective sub-theme.

Theme	Sub-themes	Example quotes
Effective infrastructure planning	Input from customers when planning projects	<i>'[...] our citizens' committees have helped guide our organisation in its decision-making process and through its strategic planning. We use it as a sounding board in order to identify what funding mechanism will be used for making different investments and what water rates might need to be. We look at what infrastructure needs are for the community going forward on a regional basis and then we get buy-in from our citizens' committee as to what direction we as an organisation should be making' (RI23.b).</i>
	Regular two-way engagement	<i>'So, it's fairly key to have your customers' feedback, and I know that many utilities, the less complaints that they get, they think that that's a good indicator, but they really need to be a partner in moving ahead</i>

		<i>with these issues, because many times when there is a crisis, they begin to ask, “Why didn’t you prepare for this,” and this is why we’re getting ahead of these chronic stresses, as these are the issues we’re facing’ (RI14).</i>
Facilitate effective local resilience initiatives	Capture varied preferences and needs to better manage trade-offs	<i>‘If you’re going to implement policy, you definitely need to have buy-in from different groups – your customer service group, [...] your public involvement group – so that everybody’s on the same page. Everybody’s heard and you aren’t making decisions that, down the line, people are going to say, “I wasn’t asked about that”’(RI13).</i>
	Tailored resilience initiatives	<i>‘Some of the challenges we face here are language barriers. We actually work with not just our community liaisons in the city, but we work with the NGOs and the community groups in that affected community to help get our message out to people that may have a language barrier. We’ve brought them onboard because they’ll have more community buy in, more community support to help get our message across’ (RI21).</i>
Advancements to innovative solutions	Appetite from customers on innovative solutions	<i>‘[It] was a huge, very, very innovative project that worked with or looked at managing storm water and the return of storm water to the river within a specific community. [...]. It’s like a real shining example of taking the time to work with communities to build in these, kind of, natural [slowing of] sedimentation’ (RI06).</i>
	Utilities pursuit for innovative for	<i>‘We actually need a different way of being regulated to say well, there’s less certainty about that method, but it is more environmentally beneficial and at a lower cost to customer, but the absolute nature of it</i>

	solutions due to customers' drive	<i>is less than building a piece of equipment that you know can give you 100% of success (RI06.1)'. </i>
Coping capabilities	Por-active/regular engagement contributes to collaboration	<i>'We are replacing a certain part of the city's pipework because...You give the reason behind it. "Please understand that there will be a traffic jam. You won't have water for a certain amount of time, and then you may experience water quality changes for a short period of time. After that, you will have this, this, and this under the ground, which is much better for your sake." Whatever. Then consumers will understand' (RI18).</i>
	Engagement increases customers' coping capacity	<i>'Now, if you want to check on the security of your water supply – whether you have got water or no water – you go to our website, you put in your postcode and it tells you exactly the status. It shows you a map, as well, where your postcode is. It says, "You've got no problems with supply." Alternatively, it tells you, "This is a planned interruption. The water supply will be back at 6:00pm. We apologise for any inconvenience caused. Call this number if you want us to deliver bottled water to you right away"' (RI21).</i>
	Effective behaviour-change through accessible and simple language.	<i>'You know, we've been very lucky here [...]. Again, we're out in the public, talking about water supply and water quality all the time. [...] In evenings we're visiting folks, talking about, basically, water resiliency and what it costs to be... To maintain your resiliency' (RI25).</i>

Positive and responsive behaviour-change	Effective behaviour-change through incentives	<i>'The public would not connect to the sewerage grid because you would have an increase in your water bill. People do not have this cultural perception of the importance of sewerage in their lives. That is how this program "Get Connected to the Grid" was originated lead by the state government to subsidise the low-income population and now more than 80% of people is connected' (RI19).</i>
	Effective behaviour-change after an event	<i>'I think there were two key things that worked well for us in our communication and they weren't even things we really needed to [communicate]. One was at [Lake X}, and if you see images of [Lake X] you can see that there is a bathtub ring around [it] about 130ft tall. Well, [Lake X] was at the top of that bathtub ring at the turn of the century in the year 2000. Just at about the top of the bathtub ring. Fast forward now to 2019, 2020 and Lake X] is down about 130ft from that bathtub ring, so we had a visual representation of what was transpiring from the drought that our community could see, that was evident to them' (RI23B).</i>
Prevention and/or early alerting of disruption	Open channels of communication to equip/empower customers	<i>'Of course, [here] water, it is difficult to raise the price. But most of the utilities are promoting customer engagement, explaining about the tariff revision for the customers. In addition, some utilities formulate the Tariff Revision Committee, which consists of customers. [...] The Customer Tariff Committee, the customers decide the cycle of the replacement, and decide the tariff level' (WA01).</i>

	Interactive engagement towards solutions	<i>'But I think the most effective way to get the citizens involved is through schools, so through primary and secondary education schools, and partnering with universities to help us develop a more resilient design solution. It shouldn't be improving resiliency. It should be designing resilience solutions. All of the solutions should be resilient. Yes, because I think then the parents get involved too, and they are excited. I think that's the greater impact, is actually involving the education system' (RI10).</i>
Resilience advocacy	Communicating challenges and gaining support from customers on resilience	<i>'It just would require that educational part to do outreach into various areas of the community to educate them on what it takes to produce and distribute water safely and to keep it safe in those areas' (RI26).</i>
	Resilience as a systemic effort	<i>I think if it's not an immediate threat it's hard to raise that importance level of projects such as that. I think in order to be really effective it cannot be done in a box. It needs to be a [citywide] exercise' (RI10).</i>
	Detachment of the complexities of water services	<i>'A lot of people here have no idea how our sewer system functions, but once they do and once they realise why it impacts them, then you can start talking about individual behaviour change and then you start seeing this connection between a person and a system. And that's where you'll start seeing enterprise resilience, because right now it's so disconnected, "The government's just going to take care of it"' (RI05).</i>

Passive beneficiaries of resilience	Water and water services are taken for granted	<i>'It's not like a luxurious product that you appreciate because you know you are fortunate to have, like a car or a good flat. Water is supposed to be everywhere and available in good quality for everyone. Also, I think it's the human mind. If you have something, you take it for granted after a certain period of time' (RI18).</i>
-------------------------------------	--	---

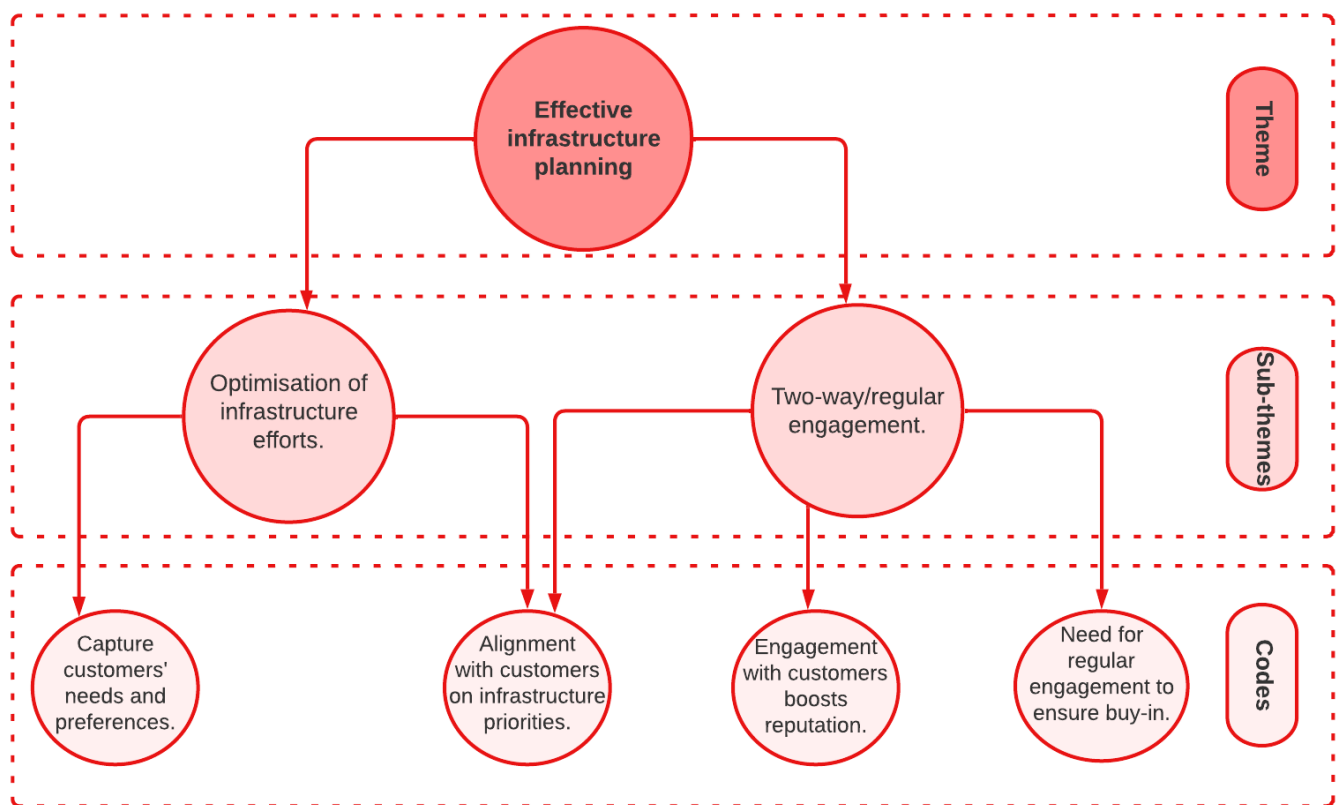


Figure 3-1: Example of the thematic mind-map to evidence the hierarchical order of codes, sub-themes, and theme.

3.3 Results

The results were organised based on the themes and sub-themes below (table 3-2). Table 3-2 clarifies the main findings by illustrating the themes' meaning and relevance to the external

contextual property of OR. Each theme represents a role that customers can play in developing OR distilled from the perceptions of utility representatives.

3.3.1 Effective infrastructure planning

Capturing customers' needs and preferences was seen to support more comprehensive resilience efforts, particularly within the realm of infrastructure planning, due to enhanced alignment with customers: *'Especially when you're planning projects, you need to have input from the [customers] [as they are the] long-term maintainers and users of whatever system you're planning, and designing, and constructing'*(RI12). Specifically, emphasis was given for a two-way engagement to ensure that resilience initiatives were compatible with the preferences of customers: *"So, over the past four years we've interacted with a million customers. [...] So, we now know [they] want the service they have today [...] They want that in the future. They want it at a price which is affordable, and they trust us to go away and figure out how to do that"* (RI06.1). Several participants also underscored the importance of capturing the perceptions from customers to set appropriate tariffs that would be affordable and enable resilience investments: *'We got our customers engaged [...] and the feedback was very instrumental in how we approach developing a stable rate structure to have sufficient revenue, even as we go through these chronic stresses [...]'*(RI14).

Table 3-2: Identified themes on the role of customers in the resilience of water services, their corresponding meaning and relevance to resilience.

Theme	Meaning	Relevance to resilience
Effective infrastructure planning.	More effective infrastructure planning as it is guided by the preferences and needs of customers.	• Learning environment in utilities due to a constant awareness of current and changing preferences from customers (Baker et al., 2018). • Clarity on the level of functionality demanded by customers, thus providing effective services that fulfil the needs of society (Doorn et al., 2019). • Prevention of unnecessary costs to manage repercussions from unpopular initiatives (Akhmouch & Clavreul, 2016). • Positive reputation of water utilities leading to enhanced trust and collaboration (Sawalha et al., 2015).
Facilitate effective local resilience initiatives.	Initiatives are steered by a more accurate understanding of needs and preferences from different customer segments	• Broad resource network built with different customer segments (Lengnick-Hall et al., 2011), may support utilities to gain a more granular understanding of resilience ‘of what to what?’ from different socio-economic groups (Carpenter et al., 2001). • Utilities are less susceptible to reputation damage as resilience efforts are accounting the potential effects (positive or negative) on individuals (Doorn et al., 2019).

	of varied socio-economic background.	• Reduced power asymmetries and potential to deliver broader benefits and minimise negative impacts due to better assessment of trade-offs (Ananda et al., 2022). • Disaster preparedness and recovery instructions are more effective as engagement is tailored to the realities of different communities (Reed et al., 2018). • Social minorities may gain the confidence through psychological safety to ‘speak up’ about issues in their communities as well as their preferences, and needs (Lengnick-Hall et al., 2011).
Advancements to innovative solutions.	Customers’ support reinforces utilities’ buy-in to experiment with innovative solutions even though such solutions may not be fully proven as effective.	• Shift in organisational culture to one which embraces inventiveness and experimentation have been widely discussed as enablers of resilience in the water sector (Giffoni et al., 2022). • Consideration of knowledge that is disparate to deep established assumptions, thus supporting learning of different perspectives (Pahl-Wostl, 2009).
Coping capabilities.	More informed customers on the challenges faced by	• Enhanced coping capacity at individual level that provides additional buffer and capabilities to water utilities during a disruptive event (Balaei et al., 2019a).

	utilities and how to act during an incident may support the development of higher tolerance levels to utilities, as they are more likely to collaborate and avoid non-essential demands that may over-stretch utilities' ability to manage a disruption.	Customers may be more sympathetic by the consequences of an inevitable failure, therefore prone to collaborating with water utilities as well as being more resourceful and responsive to augment their own ability to cope (Lengnick-Hall et al., 2011)
Positive and responsive behavioural-change.	Behavioural change of customers towards environmental conservation and water utilities' resilience.	- Behaviour-change with visible and positive impacts may promote enhanced stewardship from customers in sustaining water services resilience (Snel et al., 2020). - Ability to ensure continuous functionality during disruption due to more responsive behaviour-change from customers which can serve as a key resource for augmented adaptiveness (Lengnick-Hall et al., 2011).

Prevention and/or early alerting of disruption	Customers as active and intentional agents in maintaining the functionality of water services.	Diffused power of building resilience (Lengnick-Hall et al., 2011), as customers can be vigilant to preventing and detecting failures of water services (Balaei et al., 2019b), thus minimising downtime and/or costs.
Advocacy for resilience	Customers as advocates of resilience to wider stakeholders.	Customers' can collectively advocate to other stakeholders to work in support of water utilities' resilience, thus setting a more propitious environment to allocate resources towards water services' resilience (Biddle & Baehler, 2019).
Passive beneficiaries of resilience	Customers detachment and apathy on the value of water services translates as water utilities being the main bearers of building resilience.	An isolated view that the responsibility of building resilience lies within utilities themselves, thus contradicting the assumptions of general resilience as an emergent behaviour of systems and individuals (van der Merwe et al., 2018).

Such involvement with customers was seen to optimise resilience projects as it prevented unnecessary costs from misaligned and unpopular approaches and provided co-benefits such as long-term trust and positive reputation: *[Any] time we agree to do works, we go to the public and we talk to them about the works. We bring them [in] busloads to see the different works that have been done before, so that they get the assurance. They then talk about the positive engagement" (RI04)*. However, in order to attain a positive and responsive disposition from customers, the participants noted a need for regular engagement: *"I think that one will be about the communication channels towards the consumers, [...]. I mean, every month or every week, you give some information on the hot topics that we are dealing with" (RI18)*'.

3.3.2 Facilitate effective local resilience initiatives

The participants flagged the importance of understanding the preferences and needs of customers from different socio-economic backgrounds to ensure that initiatives aimed at augmenting water services resilience were tailored and would not negatively impact different communities:

'Connecting a face to something. It may be a nuisance to their community, but now they have someone to contact. [...] It's really helped us to understand what the community's needs and wants are better as well. We're not just developing a cookie cutter project for the community' (RI21).

Capturing preferences and needs of different customers segments of a varied background was seen to enable more comprehensive resilience efforts as it supported a thorough

assessment of trade-offs towards equitable initiatives: *'So I would say that the foundation for resilience across that social sphere is being able to find commonality and move forward based on that. Everyone is going to come from a different place and have different objectives.'* (RI05).

There was an awareness that lack of engagement or interactions with minorities and impoverished communities could also pose risks to the resilience of utilities: *'We are getting a lot of homeless people or people on drugs trying to break into our facilities. Recently, you know, our operator was going into a pump station and a man that was on drugs and naked inside faced him'* (RI10).

The sentiment was that resilience initiatives are also about attaining a broader perspective of risks and striving for an outcome where benefits are mutual or/and disadvantages are minimised across different communities:

'It's really that change in mindset that we can't change where our water reclamation facilities were built in the past, but we can improve how it affects the communities that are around them [...] Correcting the things [...] in the past has been our goal and identifying the disadvantaged communities and how we can maximise projects to those areas. Just getting mutual benefit. Yes, it helps these communities, but it also helps us' (RI21).

Particularly, utilities from Australia, Canada, Portugal, UK, and US were quite vocal about their engagement initiatives that incentivised customers' inputs and captured diverse perspectives, such as customer forums, school events, workshops, surveys, polls,

educational platforms, and partnerships with NGOs: *‘So we tend to try and work in the community with the different groups. Generally, it’s a matter of finding the right person to talk to. But our philosophy is we’re a partner in the community’ (RI09)*. Lastly, tailored engagement supported clarity in uncovering the complexities and the different cascading effects of certain decisions or policies to different community groups:

‘A lot of people [...] feel that equity is going into an underserved neighbourhood and improving all the utilities [...]. But what happens then is all the landlords think, “Great. We will increase our rents and we will sell the property” [...] Well guess what? Those people that you are trying to help are now displaced. [...] But then what is really equity? It’s like engaging community and asking them, “What do you want?”’ (RI10).

3.3.3 Advancements to innovative solutions

Discussions around innovation were often in relation to green infrastructure – also noted as sustainable urban drainage systems (SUDS). Such discussions evinced a drive from customers for utilities to pursue SUDS initiatives: *‘[Because of a shift] of customer and regulatory expectations, instead of building tanks, we’re being driven to do more blue-green type solutions. So that’s [an external driver], but we don’t quite have our internal systems, processes, data, tools set up to allow us to quite do that yet’ (RI02)*. This topic also sparked some debate around its uncertainty and feasibility in specific contexts:

‘Can you keep the rainwater out? Yes, you can, using [SUDS], but can you put the [SUDS] in because if we have an urban community, there’s

not a lot of opportunity [...] People have said that we shouldn't build the [tunnel]. He should put SUDS in, but you'd probably have to take 20% of [the city] and turn it into a SUDS to deal with the water that falls [...]' (RI06.1).

The public support for SUDS initiatives reinforced the buy-in of water utilities to pursue efforts that were acknowledged as not completely water-tight: *'[...] Our storm water plan [...] for flood mitigation [has] been very positively received because we're implementing a lot of green infrastructure which there's a lot of appetite in the public for right now, like people want to do this'. (RI09).* However, countries such as Brazil, Hungary and Greece hardly mentioned about potential avenues for innovation or innovative initiatives that were demand-led by customers.

3.3.4 Coping capabilities

The participants emphasized that closer engagement, customers' collaboration and understanding in moments of a crisis could augment utilities' resilience: *'So if you've got good stakeholder relationships, if something happens, you can call on that network to help support you in times of need. Hopefully, that's a two-way thing. It's just a more grown-up way of going about everything' (RI02).* By regularly sharing information about water utilities actions and challenges, customers would likely be supportive in the event of service disruption:

““Oh, that's a failure. [X] Water has always engaged with us. They've come up to the forefront. They've told us exactly what has happened. They've apologised for the event. They've told us how they can help to

support us. [...] Do you know what? It could have happened to any water company.” Their attitude is much more positive’ (RI04).

This topic was of relevance due to mentions about the increasing expectations from customers on delivering water services and the little room for manoeuvre utilities had when managing threats: *“The public generally expects services to be delivered pretty much whatever the weather, and there’s not much tolerance for failure” (RI02).* The sentiment was that, through pro-active and regular engagement, customers would be more informed and better educated, thus preventing overburdening water systems with complaints given their individual augmented ability to cope during a disruptive event: *‘Where we failed was the reputation management. [Customers] were ringing us and asking for a water supply. [...] “I need to know if I should take my wife to the hospital if you are going to cut down my water supply.” That’s legitimate (RI04).*

3.3.5 Positive and responsive behaviour-change

Positive and responsive behaviour-change was undeniably seen as crucial to support resilience efforts. Some participants articulated about successful initiatives and cited some of the benefits from positive behaviour-change, such as water rationing, costs reduction, maintaining and improving natural and physical assets and enhanced preparedness: *‘Over time, they began to see that their neighbours were reducing the amount of grass that they had and then would talk about the benefits of that. “Hey, I don’t have to mow it anymore.” “Hey, I don’t have a [high] water bill anymore”’ (RI23A).*

However, it was stressed the importance of accessible and simple language when communicating about the customers’ role in collaborating with utilities to incite positive

and meaningful behaviour-change: *‘So we have learnt that by communicating a correct message to customers you can influence behaviour’ (RI07)*. It was also noted the importance of communicating relatable stories that customers could sympathise and connect by articulating how they benefit from water services in activities of their daily life: *‘Engineers typically try to start talking in terms of technology and it’s completely over their heads [...] really presenting the numbers in terms of how it affects them. [...] Really expressing things in terms of how it affects them versus how it affects us’ (RI21)*.

In addition, participants often noted that behaviour-change entailed more meaningful engagement. Some of these engagement mechanisms for behaviour-change were cited as educational efforts, financial incentives, interactive initiatives, and media campaigns that voiced issues and the value of water services:

‘[The] conservation aspect here is hugely significant when you consider that we have changed the landscape aesthetic [...] of being one from wall-to-wall grass to being one that is [...] desert-adapted plant materials. We’ve done that by, basically, paying customers to remove grass on a square-foot basis’ (RI23a).

Participants from utilities that had experienced a significant disruption to water services were more vocal about initiatives that achieved successful outcomes in relation to responsive behaviour-change from customers: *‘I think that we’re a bit unique here in that we have had a very major natural disaster that impacted almost everyone in this community. [...] so, I think that resilience is something that has been spoken about very openly at all levels within our society here[...]*’ (RI06).

3.3.6 Prevention and/or early alerting of disruption

The participants regarded that collaborative work with customers could provide prevention and early alerting support of failures. More mature and pro-active engagement that incentivised collaboration was often cited by participants from higher-income countries: *'[...] we have a protocol with [customers] to help them reduce water leaks, because of their water losses. [...] If we have to go and find different water sources [...] everyone would have higher investment costs' (RI13).*

By opening a regular channel of communication utilities could empower and equip customers in preventing and managing disruptions and maintaining well-functioning infrastructure: *'[We] have looked at water consumption patterns per student, and given them that information in terms of helping to identify leaks and stuff that's going on within their property. So that then frees up more money [...] versus them paying the water bills to us' (RI09).*

Others noted the benefits of interactive projects to identify, alongside customers, effective solutions to potential hazards: *"[...] there was an above average number of complaints about hardness of the water. [...] We designed a citizen science project [...] we sent [some customers] small test kits [to] generate data on hardness levels in their own homes" (RI20).* In addition, utilities elucidated about the symbiotic relationship with customers, where utilities would benefit from their vigilance and collaboration in relation to damaged infrastructure or environmental regeneration and customers would attain lower bills and a more resilient service: *'They take out portions that have non-native species or invasive species that don't help with erosion control. [...] It's a win-win in*

terms of we're accomplishing the environmental goals, but we're also educating the community' (RI23C).

A notable outlier case, illustrated by a lower income country, was based on a more reactive approach which was centred on cost-effectiveness. By working on a reactive basis in relation to failures coupled with maintaining low tariffs this utility established an unofficial working partnership with customers that met customers' expectations from a price and service viewpoints:

"[...] we don't do like community groups or something like that. What we do is, simply, because they call us for their complaints, [through our] service line [...]. The complaints are usually dealt with ASAP. This way we afford to focus on a reactive strategy of network service and of network [maintenance]. We afford simply by having a good relationship with the customers, not doing anything special, [just] responding to the complaints quickly and with good results and with good quality of service" (RI27).

3.3.7 Resilience advocacy

Mostly public utilities experiencing resource constraints in delivering services were vocal about acquiring the support from customers to create a collective advocacy for the resilience of water services to relevant stakeholders:

'Our funding is being constrained by government despite us as a company trying to message the real need. We are no longer sitting underneath the bushel but we're telling the public that without

*funding we are going to be constraining economic development
[...] those types of customers are now lobbying government and
putting pressure on government about funding' (RI07).*

There was a strong desire to advance initiatives that conveyed to customers the complex challenges utilities are exposed to: *'Maybe we need to act on these two fronts: advertising and bringing the population to understand our side: "we also have problems and let's act together"' (RI15).* In addition, they voiced regularly about the limits of a water utility in managing complex growing challenges in an isolated way: *"But the onus cannot just be on [an] utility to just fix something. It has to be spread across sectors. And in order to do that effectively, you need people to understand how they get value from the system" (RI05).* Several assertions were made about framing resilience as a systemic solution to a systemic problem where a wide range of stakeholders had to be part of the journey: *'So my great anxiety is how to help low-income people with regards to sanitation. [...] As this depends on other people and not only us, it definitely keeps us awake' (RI19).*

Therefore, the participants endorsed the concept of broader initiatives that encompassed political, regulatory, and social domains and did not single out water utilities as the only bearers of building water services resilience: *'There's this tendency to microscope in on single organisations or sectors to deliver a solution whereas some of what we're talking about it is societal' (RI06.1).*

Another outlier was a public utility from a lower-income country that was experiencing issues with the quality of services. The participant elucidated about the independent mobilisation and strong advocacy of customers for resilience to the actual water utility:

'This specific suburb experienced a lot of interruptions in their water supply. We were trying to come up with a solution, but could not reach a solution due to lack of resources. The community got together to protest at [our] headquarters. After that the board members quickly found resources that previously were not available to implement a project to address the problem. I think there is a real need for social mobilisation, I could not see any other way to address this issue' (RI15).

3.3.8 Passive beneficiaries of resilience

Finally, some utilities flagged issues of the detachment from customers in relation to water services resilience: *'“Well, I’m paying for the service, you sort it out.” So, expectation rises as time goes on. People just expect it. Everything to be resilient' (RI01).* They perceived customers as passive beneficiaries of water services: *'I think there are already challenges just in communicating the needs of a water utility, financially speaking, just to maintain current operations and infrastructure, aside from resilience [...]' (RI17).*

Utilities that did not have to deal with regular disruptions were less hopeful about cementing behaviour-change and collaboration from customers to augment long-term preparedness: *'Getting people to value water is probably easier in Australia than [here], where people think it rains constantly. It doesn't. [...] People think it falls out of the sky, and therefore, it just comes out of your tap, and you can use it however you want, willy-nilly' (RI02).*

In addition, there was a degree of acknowledgment of the risk to open utilities to criticism through enhanced engagement: *'If they don't get water, then they complain. Otherwise, you don't hear anything from them. If you don't hear anything from them, generally, that's, more or less, a good thing. You have to be very cautious, I think, as you go down that path'* (RI26).

However, some utilities who acknowledged the indifference to water services by customers continued to recognise the need to augment customer engagement so they could support utilities resilience: *'[The company] does some work in public events but I think is not enough. I would like to see [the company] trying to become more immersed in the communities to change the public opinion in our favour [...]'* (RI15).

3.4 Discussion

3.4.1 Appetite for meaningful engagement

This study explores the under-investigated role of customers in water sector resilience. The findings showcase the perceptions of water utility managers and re-emphasize previous findings (Baker et al., 2018; Biddle & Baehler, 2019; Golladay et al., 2020), that in order to build and sustain long-term resilience, attaining enhanced responsiveness on customer collaboration and agency will be a crucial endeavour.

Although this study has primarily focused on perceptions of the role of customers in the resilience of water services, we have identified an additional alignment with previous studies that customers' positive contribution is dependent on the efficacy of engagement actions implemented by water utilities (Golladay et al., 2020; Ofwat, 2017).

Some papers have previously noted the importance of customer engagement (Biddle & Baehler, 2019) by articulating some benefits such as behavioural-change (Baehler & Biddle, 2018), and better understanding of customers' needs and preferences (Dziedzic & Karney, 2016) and educating customers on the value of water services (Baker et al., 2018). However, they do not extensively analyse a wide-range of benefits from the lenses of water utilities' OR and do not capture in detail the breadth of roles customers could play in the resilience of water services.

Although some utilities perceived customers as passive beneficiaries of resilience, the findings indicate a strong recognition of a need to foster co-creation and mutual collaboration. These findings contradict narrow views of accounting the preferences of customers with the predominant purpose to prioritise resilience investments (Ananda et al., 2022) or encouraging outsourced participation during decision-making of water tariffs (Hendry, 2016). This limited view fails to capture the potential role of customers as a key resilience resource and agents as observed in this study. Such aspirations have been also advised by regulators (Ofwat, 2017), - without extensive articulation and supporting evidence - thus indicating a degree of alignment by water managers and regulators on the level of input from customers towards water sector resilience.

Across the participants there was a desire to address issues related to disengaged and uninformed customers that impacted how they valued the importance of water services and their propensity to collaborate with water utilities. Calls from utilities' managers for intensified quality of engagement is quite timely, given latest discussions on higher expectations and scrutiny from customers (Baker et al., 2018) due to a more easily accessible exchange of information as part of an increasingly digital world (EUM, 2016).

However, such aspirations were articulated more extensively by utilities in higher-income countries, likely due to prominent guidelines from regulators to advance customer engagement (Ofwat, 2017 & Ananda et al., 2022) (such as in the UK and Australia) and stronger political repercussions from undemocratic decisions and lack of transparency - specifically from municipally managed utilities in the US (Lawson et al., 2020; Ananda et al., 2022; Biddle & Baehler, 2019). Higher-income countries noted more strongly the need for two-way interactive engagement through polls, workshops and surveys. Whereas lower-income countries mentioned the need to increase one-way information sharing (either from utilities or customers), with very few mentions of more interactive and proactive approaches. This indicated higher maturity on more profound types of engagement by utilities from higher-income countries, likely due to them being less affected by service deficiencies and resource constraints.

In themes that identified customers as agents of behaviour-change and prevention/early alerting of disruption the participants elaborated more strongly on the need for educational and interactive efforts and an open channel of two-way communication. Whereas, in the remainder of themes the participants highlighted fairly basic types of engagement initiatives, such as consultation and information-sharing (Arnstein, 1969). We argue that lengthier initiatives that entails deeper changes in values and behaviours of customers may require comprehensive and long-term forms of engagement, such as educational, interactive and deliberative efforts Reed et al (2018)

The appeal for engagement by most of the participants was also attached with scattered cues on how to harness agency and collaboration from customers, therefore, suggesting a

need to advance pragmatic and targeted modes of engagement to different customers segments to support a more receptive audience and prompt collaboration. However, promoting active engagement between customers and utilities, has been noted to be a difficult task, where lack of resources (Littlechild, 2014) and indifference from customers (Ananda et al., 2022) have been acknowledged as key barriers.

Given that lack of resources was seen as a barrier for effective customer engagement, water utilities from lower-income countries experiencing service deficiencies and scarce resources, may have to manage compounded difficulties to harness customers' agency and collaboration for resilience. In addition, they may not experience the strong regulatory drivers for meaningful engagement as strong as water utilities in the UK, US and Australia (Ofwat, 2017; EPA, 2017; Ananda et al., 2022; Lawson et al., 2020).

However, greater engagement towards increased agency and collaboration, could alleviate current financial resource constraints experienced by water utilities specifically from lower-income countries (Giffoni et al., 2022). Forging stronger alliances with customers could reduce costs and/or increase budgets through positive behaviour-change and fairer tariffs derived from customer advocacy, thus supporting the maintenance and investments in physical infrastructure and services. Therefore, boosting the contextual property of OR – external positive relationships and social networks – can have significant impact in the sustained functionality of physical infrastructure.

The findings showcased a set of interventions that complements resilience theory for the water sector relating to customer engagement. The following are presupposed to facilitate and sustain a more effective engagement and drive agency of customers:

- (1) simple and relatable language;
- (2) continuous communication and engagement;
- (3) educational and interactive initiatives;
- (4) identification of commonalities and management of trade-offs (Golladay et al., 2020);
- (5) provide tangible and intangible incentives for collaboration (Hahn et al., 2020).

Although they have been identified in isolation in previous research, they have not been identified as a group and in the context of resilience for the water sector. This set of interventions is an initial step towards understanding how to unlock and leverage customers collaboration and agency for the resilience of water services.

However, as proposed by Ananda et al., (2022) and Reed et al., (2018), engagement with customers must match the resilience objectives and the local context, therefore the above interventions are not a prescriptive, instead they are discretionary according to different needs and contexts. As observed in the context of a lower-income country, a closer relationship with customers grew organically and on a reactive basis in response to the primary objective to keep tariffs low, thus highlighting the need to adapt engagement based on the contextual idiosyncrasies. Future work should build on the intervention group above to create an engagement framework that is context sensitive (Pahl-Wostl, 2009) within the realm of water services resilience.

It is worth noting, however, that other factors were also highlighted as triggers to enhanced responsiveness in customer collaboration, such as customers that have experienced some type of disruption or have felt first-hand detrimental effects driven by lack of resilience investments. In addition, it is important to consider contexts that drive a more conscious behaviour. As noted above, a desert-like environment coupled with incentives encouraged customers to change their garden towards a more desert-friendly landscape. These contextual factors should be more extensively documented in future research to expand understanding on the range of motives that instigate collaboration from customers as they could inform the design of future customer engagement initiatives. To our knowledge the factors above have not been articulated widely in customer engagement research for the resilience of the water sector.

It was identified a slight narrative change towards stronger acknowledgement of the need for deep social capital founded on a reciprocal network of trust and support in relation to water services resilience. This adds a dimension to extant literature which predominantly elaborates on water utilities' interactions with customers as a way to comply with calls for enhanced engagement from regulators (Hahn et al., 2020; Pawsey et al., 2018), to handle customers' complaints (Akhmouch & Clavreul, 2016) to ensure customers' interests are reflected in decision-making (Ananda et al., 2022), and to build customers' confidence of utilities performance (Biddle & Baehler, 2019).

From a contextual lens of OR, which in this study encompasses external relationships as posited by Lengnick-Hall et al., (2011), developing deep social capital with customers can furnish water utilities with a supportive network prior, during and after a disruptive event (Pahl-Wostl et al., 2007). Secondary benefits may also arise, such as an increase of

utilities' intellectual capital through the capture of a variety of preferences and needs. Intellectual capital could be also manifested as wider awareness of interdependencies and resilience/vulnerability dependencies between individuals/customers (micro) and water services' (macro). Such benefits may facilitate long-lasting interactions and a stronger support network between customers and utilities when managing disruptions towards a more granular awareness of the actors and contexts that influence water services resilience.

As shocks and stresses grow in intensity and scope, water utilities may need to clarify more incisively what is needed from customers in the quest of augmenting resilience of water services, and the limitations of utilities themselves to adapt and prepare against disruptions in an isolated way. For water customers, this may entail more profound and lasting behaviour-changes, higher tariffs as well as intensified participation and awareness of the complexities of water services. On the other hand, sharing the resilience responsibility with customers may open debates about an unclear boundary of water utilities' accountability in ensuring present and future resilience of water services. Prospects on policy-making for regulators may lie on more accurately delineating their expectations from water utilities and their views on the role of customers in facilitating resilient water services.

3.4.2 Resilience beyond the boundaries of water utilities

As observed, customers may steer and complement infrastructure planning objectives, thus preventing risks to reputation, trust and unnecessary costs involved in managing unpopular decisions. From a theoretical lens, customers can assist water utilities in answering the established inquiry in resilience literature of delineating 'resilience of what

to what?’ (Carpenter et al., 2001), as customers can provide constructive input in the perturbations, regions and communities that should be targeted as the focus for infrastructure resilience. From a practical perspective, such an endeavour may provide a tangible measurement to determine optimal operational levels of functionality that utilities should strive towards (van der Merwe et al., 2018). However, specifying an aspired resilience level based on input from customers may not necessarily translate as the generalizable goal across different temporal, geographical and social scales (Carpenter et al., 2001; Reed et al., 2018). Therefore, practitioners should take notice of the need for diversify perspectives of resilience across different stakeholders, regions, and scales.

Innovation has been extensively associated as an important capability of resilience for the water sector (Crick & Bentley, 2020). As observed, customers could trigger the appetite and reinforce the need for innovative solutions, even though water utilities may be limited to applying tried and tested approaches due to the unvarying impetus to seek reliability. Utilities could capitalise on customer support for innovation by delivering targeted innovative efforts, thus augment positive reputation, innovation buy-in, and wider water sector resilience. However, it is worth noting that water utilities from lower-income countries, that experience deficiencies in water services due resource constraints (Giffoni et al., 2022), may not have the agility or surplus of resources to invest in innovation initiatives demand-led by customers, given that such resources would likely be devoted towards maintaining basic functionality.

The endorsement of SUDS by customers evidences that exploring innovative yet uncertain solutions in a reliability-focused environment within water utilities, will be

increasingly regarded as integral to respond to calls to emerging trends, such as environmental conservation and sustainability. Steered by customers' preferences, utilities may have to challenge the dominant cognitive frame of striving for reliability (Giffoni et al., 2022), towards also accommodating efforts of experimentation with not fully matured solutions. This way, utilities may advance expertise and capabilities in novel areas that support resilience whilst also fulfilling aspirations of customers. Therefore, this indicates the crucial role customers can play as drivers for organisational culture change; from a heavily fail-safe environment towards a receptive stance to experimenting with novel solutions.

Baker et al., (2018) has hinted that customers could be drivers for innovation, given that regulators interaction with water utilities does not provide enough traction for significant innovative advancements. However, to our knowledge, this paper is the first to elaborate more extensively that customers could be important actors in incentivising innovation initiatives in water utilities. However, on a more practical level such a change in paradigm towards experimentation cannot only rely on customers' appetite, as it will also entail the overhauling of culture and processes, as well as a change in strategies of future investments.

In addition, a new debate emerges regarding how to manage the tension of responding to regulators and customers' calls for innovation and maintaining reliable water services, whilst juggling pressures of resource constraints, growing shocks and stresses, and enhanced vulnerability from systemic interdependencies (Giffoni et al., 2022). Nevertheless, as a key tenet of resilience (Ofwat, 2017), a propitious path for innovation may lie on more strongly emphasizing its importance in utilities' strategies and to attain

tangible buy-in from leadership for innovation to coexist proportionally with a deep-rooted reliability and mechanistic stance of water utilities (Baehler & Biddle, 2018). Customers' drive for SUDS may provide a window of opportunity to support a practical transition towards cementing a utility environment more conducive to innovation.

Diversified perspectives emerging from different socio-economic customers may support resilience efforts that are fairer to a diversity of users. In addition, such an approach may develop wider awareness of the value of water services given that engagement is sensitive to different socio-economic communities, thus increasing the chance for collaborative behaviour. A tailored approach to customer engagement has been noted by Doorn et al., (2019), who flagged the need to identify the resilience needs more thoroughly of infrastructure services based on different social groups.

Grasping the perceptions of different customer segments is relevant due to socio-economic variables that influence needs and preferences of different communities. Specifically, in countries with contexts of a higher degree of socio-economic disparity and illegal settlements without legitimate water and wastewater connections, such as Brazil, constructive engagement with customers can capture a more granular picture of the environment of vulnerable communities towards appropriate sanitation provision and a targeted approach to resilience investments (Guimarães et al., 2016).

Poor communities are often excluded from decision and policy-making related to water services (Guimarães et al., 2016), are less likely to engage due to lack of resources (Lindsay et al., 2019) and individuals with lower levels of education are less likely to tolerate service disruptions (Petersen et al., 2020).

The participants highlighted the need to target different demographics to empower their input and gain understanding of their different perceptions. Although literature supports the need for tailored engagement (Dziedzic & Karney, 2016; Golladay et al., 2020) it does not articulate in detail the need for doing so in relation to resilience. From a more panoramic perspective of general resilience, customised engagement can support utilities in making more comprehensive resilience decisions given their granular knowledge of different contexts (van der Merwe et al., 2018), thus preventing unintended negative consequences (e.g.: a resilience initiative that is beneficial to one community may be detrimental to others). As such, the knowledge attained on the idiosyncrasies of different customer segments, may support a better assessment of trade-offs involved. This can minimise negative impacts to specific systems and communities, thus supporting general resilience development (wider resilience derived from emergent behaviour of systems and individuals) (Carpenter et al., 2012; van der Merwe et al., 2018).

In addition, better quality and tailored engagement with customers can support social justice (Doorn et al., 2019) and development of empathy to the importance of water services, as minorities and other customers' segments are more likely to have the psychological safety to also be accountable agents in shaping resilience initiatives affecting their communities, sharing more widely their preferences and needs, and being more forthcoming to collaborate with utilities. An open flow of communication between both utilities and customers can foment continuous learning of their unique challenges and needs, thus triggering behaviour-change, and adjustments to well-established assumptions and behaviours (Lengnick-Hall et al., 2011). Future work should identify ways to effectively target customers from different socio-economic backgrounds in

resilience discussions to prevent the marginalisation of under-privileged communities and skewed resilience initiatives. In particular, to clarify how to foment responsiveness and accountability of customers that may not have the available means and resources to be active agents on the resilience of water services.

3.4.3 *Bottom-up resilience*

From an international perspective we identified across the results that higher-income utilities have more pro-active and elaborate modes of engagement. In contrast utilities from lower-income countries appeared to interact more reactively with customers. Although, lower-income countries acknowledged the need to do more in relation to engagement in support of resilience, resource constraints suggested to be a major road-block.

We argue that the majority of literature on resilience that advises and outlines different modes of engagement may not be suitable from lower-income countries as they derive and target utilities from higher-income countries (Ananda et al., 2022; Golladay et al., 2020; Pawsey et al., 2018). This suggests a lack of academic resources tailored for the needs and realities of utilities from low to middle-income countries. Utilities from lower-income countries may not only be hampered by a lack of internal resources, but they also may not have access to the theoretical tool-kit required in advancing customer engagement conducive of water services resilience. This denotes that lower-income countries might have a lower level of maturity in comparison to high-income countries in leveraging the positive role customers could play in advancing resilience. Which is unfortunate because fomenting customers as supporters and agents of resilience could complement documented challenges regarding lack of resources and quality of services

(Giffoni et al., 2022). Future work should focus on the unique context and constraints of lower-income countries by identifying cost-effective engagement initiatives that are conducive of OR.

As evidenced, regularly engaged and well-informed customers of utilities' ongoing challenges, can empathise with the complexities afflicting the resilience of water services and provide enhanced understanding and support in moments of crisis. Water utilities can benefit from stronger ties with customers, manifested as resource networks that is built over-time through regular engagement to be called upon in moments of need (Lengnick-Hall et al., 2011). Such resource networks may enhance collaboration and decreased number of queries during an event, thus freeing up resources to other impending matters. In addition better-informed customers, that trust their utilities, are less likely to over-react and over-stretch utilities during disruptions, therefore supporting a quicker resumption of services (Balaei et al., 2019b). However, as stated by Reed et al., (2018) the level of social engagement must match the goal of the initiatives. Therefore, from the perspective of building lasting water services resilience, we argue that developing supportive resource networks with customers may require early engagement that is prior disruptions, as a long-term strategy of mutual understanding and collaboration that may be capitalised from in moments of crisis (Petersen et al., 2020).

There is an untapped potential to more actively support customers on how to prepare for and react during a disruption, to learn on what to look for to identify a potential failure and educate them on the importance of water services resilience to the progress of their daily lives and personal goals. More equipped and literate customers on water services resilience may lead to a more favourable context to maintain and resume functionality of

water utilities. However, we argue that different customers' experiences and demographics (age, income, culture, education levels, etc) must also be considered, given that customers that have experienced some types of disruption are more likely to collaborate and certain socio-economic backgrounds may be less prone or able to collaborate (Petersen et al., 2020).

The cumulative effect of individual level resilience can have a positive impact to water utilities' adaptive capacity (Tracey et al., 2017). The findings showcased that better equipped individuals, in relation to water services disruptions, can support utilities by being knowledgeable on how to act and resourceful to meet their own immediate needs (Balaei, et al., 2019a; Petersen et al., 2020). Similarly, customers can hold a sentiment of stewardship and support utilities with early alerting of disruptions or advocating in favour of resilience investments (Biddle & Baehler, 2019).

3.5 Limitations:

Although this study captured water utilities' managers views of the role of customers in building resilience, we are aware that a gap remains to be filled on how actual customers perceive their role in supporting water services resilience, specifically, their willingness to change behaviour and becoming active agents of resilience. Similarly, to limitations highlighted by Giffoni et al., (2022), we attempted to ensure a prudent illustration of themes underpinned by the research questions, as opposed to the number of codes. This enabled a more uniform representation of findings as it minimised the skewing by the varying number of participants per each region. Furthermore, the participants that were members of the steering group could have been a potential source of bias as they were familiar with concept of resilience in and were eager to explore more about it for the water

sector. However, we aimed to manage this potential bias by recruiting external participants to the steering group that had less experience and understanding of resilience.

3.6 Conclusion

Although customer engagement has been recognised as an important component for the resilience of the water sector and claimed to be a key contextual characteristic of OR, advancement is sparse in relation to meaningful engagement that evokes two-way collaboration and forges collective agency for resilience. This paper delved deep into the under-examined area of the role of customers in building water services' resilience through thematic analysis of interviews with managers and senior-managers of the international water sector. Whilst customers' active involvement in the resilience venture has been recognised as paramount, the findings divulge that developing strong social ties that enable two-way engagement and communication is highly dependent on the effectiveness of customer engagement activities employed by water utilities. Fomenting such relationship is of importance because the roles here identified can be crucial in supporting the management of systemic and more complex disruptive events. Although it was recognised a role of customers as passive beneficiaries of resilience, positive roles were also identified, such as facilitators of more targeted initiatives, contributors to higher tolerance levels and positive behaviour-change, and resilience advocates.

Calls for the advancement of social capital between utilities and customers indicate a recognition of a need to foment stronger networks of collaboration that seeks quality of engagement and go beyond the conventional impetus of capturing preferences and needs to assist decision-making on resilience investments. However, little is known regarding pragmatic and effective modes of engagement that substantially advance customers'

collaboration and agency for water services resilience. A set of interventions were observed to assist the development of positive engagement: (1) simple and relatable language; (2) continuous communication and engagement; (3) educational and interactive initiatives; (4) identification of commonalities and management of trade-offs; and (5) tangible and intangible incentives for collaboration.

Recognition on the importance of honing and maturing engagement efforts were attached to the interdependency between individuals and utilities in building resilience. Two-way engagement was seen to provide utilities with a more comprehensive picture of trade-offs, diversity of views and emerging threats. A relationship of trust and collaboration with customers was seen to enhance the reserves of coping capabilities, augment responsiveness for positive behaviour-change, foment a collective vigilance on potential failures and disruptions and inspire advocates and stewards of the resilience of water services.

As the motivation for meaningful engagement and the development of strong social capital with customers were highlighted, utilities will need to explore ways to address key roadblocks. For instance, resource constraints (more acutely felt by lower-income countries) currently experienced by utilities (Giffoni et al., 2022) are major hindrances to engagement initiatives as they entail considerable time and financial resources. Secondly, utilities will need to be better equipped on how to tailor engagement initiatives with different socio-economic communities to ensure meaningful interactions that foment positive collaboration, diversity of perspectives and agency. Thirdly, utilities may have to actively work with regulators to better delineate how customers can support the present and future of water services' resilience. For lower-income countries, future research

should explore ways to leverage customer collaboration based on their unique realities. Finally, utilities should consider ways to develop their reserves on different types of engagement to target approaches that are most suited to different customers profiles that lived through different levels of disruptive experiences.

4 Uncovering the links between Organisational Culture and Organisational Resilience for the water sector: a framework validation.

Abstract

Although organisational culture is a key factor for organisational resilience (OR), little is known about favourable cultural attributes in the context of water sector resilience. This paper demonstrates important links between organisational culture and OR and showcases the perceptions of water utility managers on the desirable attributes of organisation culture for OR. Drawing from literature and through a Delphi approach, we devised and validated the ‘Organisational Culture of OR Framework’ which was composed by the following attributes: ‘adaptiveness’, ‘collaborative integration’, ‘inventiveness’, ‘sense of pride’, ‘trust’ and ‘well-being’. Thematic analysis identified an over-emphasis on standards and procedures that may hinder positive changes towards a culture of organisational resilience. Addressing organisational barriers was perceived as a pre-requisite to cultural changes which may lead to inaction. The sector’s drive for talent recruitment and staff retention translated as an appetite to foment deeper relational ties with staff. The validated framework serves as a steppingstone for future research and the development in practice of an organisational culture of organisational resilience in the water sector.

Keywords:

‘Organisational culture’, ‘organisational resilience’ and ‘water utilities’

4.1 Introduction

Augmenting the resilience of water services is a cornerstone strategy for the water sector (Baehler & Biddle, 2018; Smith et al., 2019). Resilience can be fomented through the built environment and technologies, as well as intangible assets in the social and organisational domains that provide sentience to infrastructure systems (Hollnagel, 2014). Resilience in the water sector often focuses on efforts that prevent failures from specified threats affecting the physical environment (Rodina, 2019). As such infrastructure resilience, which is greatly influenced by technocratic and linear perspectives, has been the basis of resilience initiatives to sustain the functionality of water services (Brown et al., 2017; Lawson et al., 2020; Smith et al., 2019).

Whilst there is a recognised need to develop resilience, human domains have been under-explored in resilience research for water utilities (Lawson et al., 2020), therefore little is known about social and organisational capabilities conducive to resilience. This is of concern given that humans provide the needed sentience to ensure a resilient performance to infrastructure services and assets (Hollnagel, 2014). Leveraging social capabilities has been argued to enhance flexibility and adaptiveness to complement rigid and technocratic approaches that may not be responsive or comprehensive enough to manage emerging and complex threats affecting the water sector (Rodina, 2019a). The increasing interest in understanding how people and organisations can develop resilience capabilities (Baker et al., 2018; Naderpajouh et al., 2018; Smith et al., 2019) highlights the significance of exploring how the organisational dynamics and culture can be shaped to support water utilities' resilience (Giffoni et al., 2022).

4.1.1 *Organisational resilience and the water sector*

Organisational Resilience (OR) encompasses the development of social capabilities in the organisational environment towards ‘building the ability to effectively develop situation-specific responses and implement activities to absorb and capitalize on disruptive surprises that threaten organization survival’ (Lengnick-Hall et al., 2011, p.2). OR can be fomented in practice through the applied fields of risk management, business continuity and adaptive behavioural capabilities (Brown et al., 2017). Whilst in theory OR focuses in exploring the relational dynamics as well as cognitive, behavioural and contextual properties towards building flexibility and adaptiveness to manage and capitalise from internal and external shocks and stresses (Crick & Bentley, 2020; Lengnick-Hall et al., 2011).

Expanding the resilience focus from linear infrastructure-based initiatives towards more systemic approaches, encompassing human interaction and behaviour, may support enhanced flexibility and adaptability. However, OR has been underutilised in the research for the water sector, with just a few OR assessments (Brown et al., 2017; Sweya et al., 2020) that do not delve deep into the context of water utilities and fail to clarify the links between OR and organisational culture, and their relationship’s relevance to the sustained functionality of water services. This is problematic, firstly, because the water sector has signalled the need to explore and hone social and organisational resilience capabilities (Ofwat, 2017; Smith et al., 2019). Secondly, organisational-based risks and challenges have been flagged as a potential detriment to water utilities resilience, such as: under-developed learning and creative cultures (Baehler & Biddle, 2018; Sweya et al., 2020) organisational silos (Brown et al., 2017; Giffoni et al., 2022) challenges to recruitment

and retention of talent (EUM, 2016), and lack of communication and information-sharing (Summerill et al., 2010).

4.1.2 Organisational culture for water sector resilience

Water utilities must constantly adapt to threats and events from internal and external environments. Organisational culture is crucial in effectively acting upon new demands through adaptive responses (Denison & Mishra, 1995) and plays a key role towards organisational development, change and resilience (Alvesson, 2002; Smith et al., 2019). For the water sector organisational culture is mentioned as a key variable towards a preventative risk governance (Summerill et al., 2011), as a force that hinders or foster organisational buy-in for change (Summerill et al., 2010) and as one of the main components that underpin resilience advancements in water utilities (Smith et al., 2019). There is a growing desire in the water and infrastructure sectors to better understand how organisational culture influences OR (Smith et al., 2019; van der Merwer et al. , 2018) and how to engender positive culture change (Baker et al., 2018; Farrelly & Brown, 2011) to support and meet present and future needs.

The importance of identifying cultural issues that impair the resilience of infrastructure systems (Taylor et al., 2017) or advise on how to build a culture that supports OR (Giffoni et al., 2022; van der Merwe et al., 2018) has been underscored. In particular, Smith's et al., (2019) study with water managers flags a need to identify organisational culture enablers and barriers of OR. Although an appetite for culture change exists to enhance preparedness to emerging threats (Baker et al., 2018; Giffoni et al., 2022), little is known about the main characteristics of an organisational culture conducive to OR in water utilities. Whilst some studies propose individual elements that support a culture

conducive to resilience, such as experimentation, creativity and proactiveness (Farrelly & Brown, 2011; Mafabi et al., 2015; Summerill et al., 2010; Sweya et al., 2020), as far as we know, no studies to date have looked exclusively into identifying and capturing from utilities representatives a set of desirable attributes for OR and articulating their links in the context of water utilities.

4.1.3 Theoretical perspective of organisational culture

Organisational culture has been theorised as collective learning from external adaptation and internal integration that generates cumulative patterns of underlying assumptions, beliefs and values that influence behaviour (Schein & Schein, 2017). It has also been claimed to derive from unwritten social rules that influence the way a group of people think, feel and act (Hofstede, 2010) and as a set of socially shared meaning that give rise to actions (Alvesson, 2002). Regardless of varied perceptions and a multitude of definitions on organisational culture, its principles revolve in the social realm through values and beliefs which are shaped by collective adaptation, learning and interactions that translate as organisational behaviour (Alvesson, 2002; Schein & Schein, 2017).

According to Schein & Schein, (2017) organisational culture can be observed at three different levels: (1) artefacts: tangible and visible behaviour, structures, guidelines, and processes; (2) espoused beliefs and values: ideals, goals and conscious rationalisations that support a normative frame of a group; and (3) underlying assumptions: a group's unconscious cognitive fabric comprising of values and beliefs that have been repeatedly proven as effective. Whereas Hofstede, (2010) claims that organisational culture is underpinned by values and composed of (1) symbols that carry a distinct meaning to a particular group; (2) heroes: individuals that are perceived as models of behaviour; and

(3) rituals: manners, activities, and ceremonies. Elsewhere, Alvesson, (2002) states that key concepts of organisational culture are: (1) meaning: socially shared interpretations of the organisational context that shape actions, and (2) symbols: words, actions, objects that are collectively interpreted in a unique way.

We utilise the three cultural levels proposed by Schein & Schein, (2017) – previously applied by Summerill et al., (2011) (as seen in table 4-1) to provide greater meaning to the findings. This model was chosen due to its pragmatic separation of tangible and non-tangible elements of organisational culture which adds clarity when articulating about culture given its abstract nature.

We have also adapted Schein & Schein's structural model by splitting the artefacts layer into two layers – see table 4-1: (1) artefacts as observed behaviour; and (2) artefacts as structures and processes. Our rationale for the modification of the artefacts layer was that, as opposed to 'observed behaviour', 'structures and processes' are not always determined by underlying assumptions as previously argued by Schein & Schein. Especially because published structures and processes may not always align with personnel's unconscious rationalisations and can be a manifestation of the organisational rhetoric that is not demonstrated in practice.

Organisational culture heavily influences the realisation of desired organisational strategies, therefore, ensuring the alignment between water utilities' organisational culture and aspired resilience strategies may support the development of OR capabilities (Alvesson, 2002; Hofstede, 2010). Here we pose the question: *'What are the desirable attributes of organisational culture for OR in international water utilities?'*. To investigate this, we capture the perceptions of water managers, and devise and validate

an organisational culture of OR framework through an iterative consultation process with water representatives.

Several cultural studies across different sectors have devised frameworks to steer understanding on cultural characteristics that support a desired behaviour or for the management of threats. For instance, in the field of cyber-security a cultural framework was created to assist the detection of threats (Georgiadou et al., 2022a) and assess the security readiness of organisations (Georgiadou et al., 2022b). Elsewhere, Tolah et al., (2021) devised a framework towards the development of a security culture by identifying factors that influence and reflect such culture. In the insurance sector a framework was created to support the development of OR with a focus on organisational culture (Dahmen, 2023). For the water sector, such framework could expand the perceptions of practitioners to be vigilant, of not only physical, but organisational threats, and provide a baseline of conducive cultural attributes for the development of OR.

The water sector could benefit from a similar framework, given that cultural attributes of OR and their characteristics are under-explored and crucially, because organisational culture heavily impacts the propensity for resilience behaviour in utilities. This study devises a framework with cultural attributes perceived to be conducive to OR. The validated framework serves as an initial building-block for future research to better understand and develop an organisational culture of OR in water utilities.

Table 4-1: Structural levels of organisational culture adapted from Schein & Schein (2017).

Structural levels:	Description:	Interaction with other cultural layers:
--------------------	--------------	---

Artefacts as observed behaviour.	Manifestation of culture through daily actions, routines, habits, and interactions.	Determined by underlying assumptions.
Artefacts structures and processes.	Organisational charters, guidelines, published values, physical environmental and technology.	May be determined by espoused values and beliefs and underlying assumptions.
Espoused values and beliefs.	Values and beliefs endorsed by leaders which have not been empirically tested as effective.	Reflected in artefacts as structures and processes. May not necessarily influence artefacts as observed behaviour, given it may not be aligned with underlying assumptions.
Underlying assumptions.	Unconscious rationalisations composed of tacit values and beliefs that have been empirically proven as effective by the organisation.	Determine artefacts as observed behaviour.

4.2 Methods

An organisational culture of OR framework was developed through the identification of cultural attributes and a Delphi validation process with water sector professionals. As evidence for the framework development and as the underpinning rationale for the choice of attributes, we appraised studies that had a clear link between organisational culture and OR from a variety of fields relevant to the water sector; such as healthcare (Carter &

Hawkins, 2019), safety science (Dekker & Breakey, 2016), resilience engineering, organisational resilience (Crick & Bentley, 2020), organisational behaviour (Powley, 2013) and high-reliability organisations (Harvey et al., 2019).

We utilised the resilience analysis grid (RAG) by Hollnagel, (2011) due to its proven simplicity and flexibility (Rodríguez et al, 2020) to present a clear link between the cultural attributes identified and OR, as seen in table 4-2. The RAG was utilised for the purpose of framework creation and to provide a logical resilience justification on the identified attributes. To our knowledge this methodical linkage between the RAG and the cultural attributes conducive to OR has not been done before. Such linkage clarifies how the identified attributes may have a positive impact in the resilience of the water sector and further justifies the attributes selection for this study. The RAG asserts that resilience performance is composed of four abilities: (1) **respond** to consistent or infrequent events; (2) **monitor** disturbances and opportunities internally and externally; (3) **learn** relevant lessons; and (4) **anticipate** emerging threats, pressures, and opportunities.

We proposed eight cultural attributes in the initial framework (table 4-2) which served as the basis for the validation process. These attributes were derived from an exploratory literature review containing studies from sectors relevant to water utilities. Table 4-2 showcases the identified cultural attributes, their descriptions, links to RAG framework and the studies underpinning their rationale. The framework's attributes and their descriptions - without the RAG linkages to not bias their perceptions - were posed to participants so they could critique and refine the framework via two survey rounds – see more in figure 4-1.

Table 4-2: Organisational Culture of OR Framework and its resilience rationale through RAG.

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
Adaptiveness	The organisation is equipped with a collective ability to repurpose existing systems and behaviour as needed through proactive behaviour and a constant improvement of established ways of doing things.	Respond: Built-in flexibility to manage events that cannot be foreseen.	(Crick & Bentley, 2020; Pollard et al., 2013; Sheffi & Rice, 2005; Smith & Plunkett, 2019)
		Monitor: Vigilance and eager to swiftly read the environment towards effective responses, even if that means challenging the <i>status quo</i> to improve preparedness.	
		Learn: Reflection of internal/external lessons learned and opportunities to regularly improve processes.	
		Anticipate: Regularly shaping behaviour and processes in view of a changing environment.	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
Collaborative Integration	Information is shared between teams and departments and different viewpoints and practice are encouraged to be shared and integrated.	Respond: Cooperative interactions and better curation of suitable solutions due to an integrated assessment of feasible and appropriate responses.	(Brown et al., 2017; Crick & Bentley, 2020; Hopkins, 2006; Tracey et al., 2017)
		Monitor: Timely and aligned information-sharing on the development of emerging events.	
		Learn: Ability to augment expertise and coping capabilities by learning from different viewpoints and expertise.	
		Anticipate: Amplified awareness of threats due to diversity of perspectives and how they may affect different areas in the organisation.	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
Inclusiveness	Individuals across the organisation have equal access to contribute in the decision-making of new policies and opportunities for growth, as explicit engagement is made with different personnel levels and areas prior, during and after decision-making.	Respond: More dynamic and effective responses are executed as decision-making is migrated based on experience and expertise instead of seniority.	(Arbin et al., 2021; Bisbey et al., 2021; Dekker & Breakey, 2016; Mauelshagen et al., 2013)
		Monitor: Experiential knowledge is accounted, thus broadening awareness and sensemaking of vulnerabilities.	
		Learn: Changes are implementable and seen to be legitimate as the organisational is eager to learn the different realities, needs and input from varied levels and departments.	
		Anticipate: More comprehensive understanding of different vertical and horizontal views on the prioritisation of threats	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
		(operational, tactical, and strategic, and across different teams).	
Inventiveness	Creativity and experimentation are encouraged and applied by individuals in the organisation as innovative changes are collectively welcomed when appropriate and perceived as a capability to better adapt to events.	Respond: Coping strategies are regularly renewed and refined, thus ensuring their relevance and effectiveness to a changing environment.	(Crick & Bentley, 2020; Farrelly & Brown, 2011; Mafabi et al., 2015; Rahi, 2019)
		Monitor: Wider foresight and awareness of potential threats and its systemic nature due to creative thinking.	
		Learn: Openness to learn from successful and failed experiments within the organisation and from external stakeholders.	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
		Anticipate: Promotes a reflexive environment where people can move away from the pressures of daily tasks to reflect and explore improvements to the organisation against emerging threats.	
Joyfulness	Cheerful behaviour and playful spirit in the organisation are valued and appreciated, as a positive work environment and high staff morale is collectively encouraged.	Respond: Increased willingness to cope and enhanced cognitive capabilities due to a positive interpersonal environment that prevents stress and burnout.	(Carter & Hawkins, 2019; Hartmann et al., 2021; Powley, 2013)
		Monitor: An atmosphere of camaraderie and high morale encourages staff to go out of their way to point out threats and opportunities to team members and augment collective ability	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
		to process information, leading to reduced blind spots and faster response.	
		Learn: Willingness from staff to learn, grow and buy-in to positive changes due to decreased tensions and frustrations at work.	
		Anticipate: Staff accountability in moments of detrimental events due to a nurtured team spirit, mutuality, and a sense of belonging.	
		Respond: Values and behaviour of staff are underpinned by teamwork and commitment to organisational objectives, thus	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
Sense of pride	There is a collective understanding of the importance of individual contribution to the organisational objectives, individuals experience a feeling of satisfaction from personal and organisational achievements.	enabling a coordinated response that is aligned to the organisational needs.	(Arnett et al., 2002; Denison & Mishra, 1995; Hrudey et al., 2006; Mas-Machuca et al., 2016; Summerill et al., 2010)
		Monitor: Individuals are disposed at reading the internal and external environment for potential threats and to interpret how these threats may impact their immediate area and across the wider organisation.	
		Learn: Meaningful interest from individuals to dynamically learn how their behaviour and work contribute or hinder strategic organisational objectives, specially, when priorities change.	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
		Anticipate: Actions are carefully considered prior to execution to account for how certain activities may impact the objectives of different areas in the organisation.	
Trust	Honesty is rewarded and incentivised so individuals can speak openly about problems and mistakes as there is a collective confidence of a supportive environment when raising concerns and reporting errors.	Respond: Timely responses are applied due to a collective drive to solve issues with a ‘no-blame’ approach. Individuals feel comfortable in flagging concerns and giving feedback.	(Crick & Bentley, 2020; Koronis & Ponis, 2018; Smith & Plunkett, 2019; Tang et al., 2013; Taylor et al., 2017; Tracey et al., 2017)
		Monitor: Built-in capability to effectively identify issues and opportunities due to an established experiential knowledge of a safe environment that incentivises staff to seek and raise opportunities and problems.	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
		Learn: Learning from errors and mishaps are actively encouraged as staff feel at ease to raise and discuss issues without being punished or judged.	
		Anticipate: Ability of individuals to proactively raise concerns of potential impacts to the resilience of the organisation.	
Well-being	Regular discussions across the organisation take place to identify the professional and personal needs of staff members, as	Respond: Enhanced physical and mental fitness to respond to threats and varying degrees of stress levels.	
		Monitor: Better identification of resilience challenges arising from personnel well-being that may affect water services functionality.	

Cultural attributes	Description	Cultural attributes in relation to RAG	Literature
	employees are supported to look after their physical, mental, and spiritual health.	Learn: Open discussions about well-being can improve awareness of staff frustrations or satisfaction, thus allowing tailored initiatives. Well-being initiatives may support self-recognition of weaknesses and strengths and ways to manage them towards OR.	(Mahmoud & Rothenberger, 2019; Malinen et al., 2019)
		Anticipate: Augmenting the well-being of staff supports a positive reputational image with existing and future employees, thus reducing staff turnover and enhancing the recruitment of talented individuals.	

The Delphi method is an interactive and methodical process that aims to elicit perceptions from experts to reach consensus on a specific topic (Hallowell & Gambatese, 2010). This research was carried out during the context of COVID-19 restrictions globally; thus the Delphi method was appropriate for eliciting experts' input remotely to reach consensus for the framework validation process (Brady, 2016). The suitability of the Delphi method for this study is also associated with: (a) the minimisation of dominant voices due to anonymity amongst the group; (b) given our international focus, logistical risks were reduced related to geographical boundaries (c) flexibility that allowed unsynchronised responses convenient to different schedules (Avella, 2016).

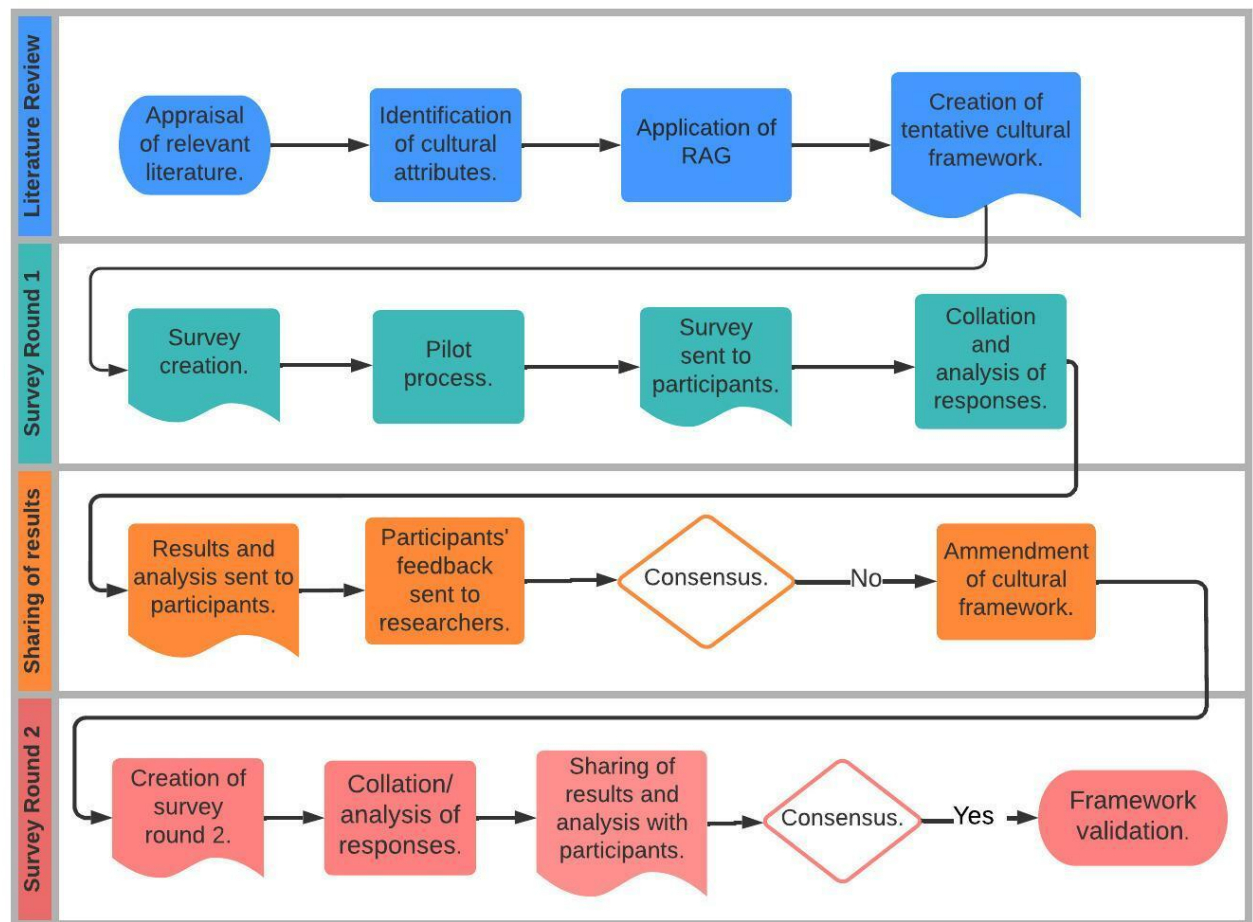


Figure 4-1: Description of the modified Delphi validation process utilised in this study.

4.2.1 Surveys' design and participants

The Delphi process applied in this study was composed of two rounds as consensus was reached in round 2. In a Delphi process once consensus is reached the results are recognised as final (Brady, 2016). The consensus criteria consisted of 80% or more participants in agreement that a specific attribute contributed to OR in accordance with Avella, (2016). The participants were given a link via e-mail to access the survey. In each survey round they were shown a description of the research design and objective as well

as a definition for OR (Lengnick-Hall et al., 2011) and organisational culture (Schein & Schein, 2017) – see more in appendices D and E. These definitions served as baseline to support their assessment on the attributes' suitability in supporting OR for water utilities.

As the participants advanced into the survey, each question presented a single cultural attribute and its description - as seen in figure 4-2. Both survey rounds consisted of multiple-choice and open-ended questions. The participants were asked whether each cultural attribute was conducive to OR of which they had to choose between three responses: (1) Yes; (2) No; (3) I do not know. Given the study's qualitative nature, as well as to minimise ambiguity the '(1) Yes; (2) No; (3) I do not know' was the chosen as the scale for the responses (Sekayi & Kennedy, 2017). The respondents could also justify their responses and were given the opportunity to critique the attributes and their descriptions through open-ended questions containing a slot for additional comments. Lastly, only in round 2 they were asked which attributes were the most and least important towards building OR in water utilities.

Before the survey questionnaire was sent out to participants, it had attained ethical approval from Cranfield University and was piloted with 5 water sector professionals. Following the modifications from the pilot, an invitation was sent out to 31 water utilities' managers of which 18 agreed to participate and 1 withdrew during round 1. Our sample was composed of experienced water sector managers and senior managers that had regular practical contact with the organisational culture and the OR needs of water utilities. Our recruitment criteria required the participants to: (a) had participated in a previous study on OR with the researchers; and (b) held managerial roles. Due to the largely qualitative design of this study, our purposive sample was composed of 17 in the

first round and 15 participants in the second round (see more in Table 4-3), as proposed by Brady, (2016). The Delphi rounds took place from May 2021 to August 2021. Participants represented water utilities from Australia, Canada, Greece, Hungary, Netherlands, Portugal, US, and UK.

Attribute 1:

Adaptiveness:

The organisation is equipped with a collective ability to repurpose existing systems and behaviour as needed through proactive behaviour and a constant improvement of established ways of doing things.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

Yes

No

I don't know.

Q5.

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q6. Do you have any other comments about this attribute?

Figure 4-2: Example of a survey question posed to participants.

Table 4-3: Description of surveys' participants.

Country	Participant's area of expertise	Round 1	Round 2
Australia	Risk and Assurance (senior-manager)	X	X

Australia	Risk management	X	X
Canada	Strategic projects (senior-manager)	X	X
Greece	Research, development, and innovation (senior manager)	X	X
Hungary	Water quality and safety	X	X
Netherlands	Research, development, and innovation	X	X
Portugal	Asset management and planning (senior manager)	X	X
UK	Risk management	X	X
UK	Risk management (senior manager)	X	X
UK	Asset management and planning (senior manager)	X	X
UK	Climate Change	X	
US	Research, development, and innovation	X	X
US	Climate Change	X	X
US	Asset management and planning	X	X
US	Asset management and planning	X	X
US	Asset management and planning	X	X
US	Asset management and planning	X	

4.2.2 Analytical process

After the collation of data, the quantitative and qualitative responses were examined in parallel to ensure no contradictions between them to identify any mistakes that could have impacted the findings – see more in Appendix C. The analysis of the first and second round were firstly conducted by assessing the quantitative responses in relation to the consensus criterion of at least 80% agreement amongst the participants. The attributes that did not meet this criterion were removed from the framework.

The secondary stage involved in organising the qualitative responses from the open-ended questions by the following: (1) responses that supported the attributes' suitability to building OR; (2) responses that challenged/refined the attributes; and (3) responses beyond the research boundary. The responses that fell into the category 'responses that challenged/refined the attributes' were utilised to refine the framework as they contained the critiques from the participants articulating why a specific attribute was not suitable or ways to improve an attribute. These responses were further classified based on: (1) frequent and major concerns; and (2) infrequent and less crucial concerns (Holsapple & Joshi, 2000) – Appendix C. Changes to the framework were steered by the responses interpreted as 'frequent and major concerns' given the consensus-seeking nature of the Delphi approach. We classified the responses in the categories above by assessing how well-articulated, the extent of the justification, and the frequency of a specific concern being raised across the participants.

Finally, the qualitative responses were further analysed to identify any cross-cutting themes from the data corpus. The identification of patterns of meaning was conducted through reflexive thematic analysis by Braun & Clarke, (2006) of which themes are

identified based on their relevance to the research objective. The researchers followed an inductive approach during the coding process which progressed from semantic (descriptive) to latent themes (underlying concepts) (Braun & Clarke, 2006).

Table 4-3: Evidence table illustrating the cross-cutting themes, sub-themes, participants' quotes and the number of respondents whose transcript contains in the respective sub-theme.

Theme	Sub-themes	Example quotes	n
Culture articulated as standards and procedures.	Culture as standards	<i>"I would say refer to the [...] BSI and ISO standards for organisational resilience and cross reference with what is there." (SR04)</i>	5
	Culture as procedures	<i>"[...] it is by working together and share data with effective data analytics that we could improve organisational resilience [...]." (SR07).</i>	5
Organisational barriers	Tangible barriers	<i>Information is shared. But it is not always organized or streamlined (SR17)</i>	7
	Intangible barriers	<i>'[...] Joyfulness is becoming extinct. As we need to become more effective regarding the work to be carried out no time is left for other things' (SR14).</i>	4

Cultivating recognition beyond financial rewards	Intangible modes of recognition	<i>'Understanding one's worth in the greater picture is essential again for mental wellbeing and being productive in the workplace' (SR11).</i>	5
	Recognition should not only be through financial rewards	<i>'Besides financial reward (salary) positive recognition is an important factor in valuing employees for the quality work they do to improve operational resilience' (SR07).</i>	2

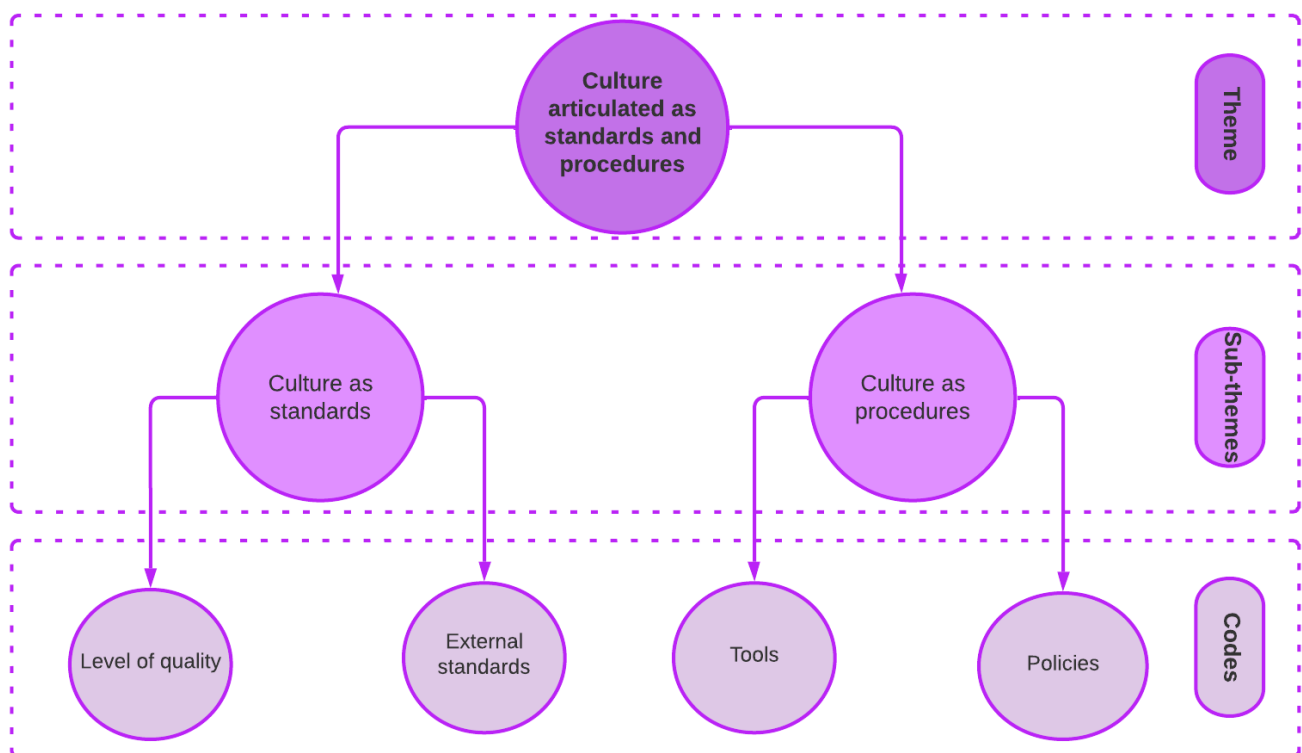


Figure 4-3: Example of the thematic mind-map to evidence the hierarchical order of codes, sub-themes, and themes.

4.3 Results

4.3.1 Framework Survey: Round 1 – quantitative assessment

The quantitative responses of the survey reveal an almost unanimous agreement on the suitability of the attributes: ‘adaptiveness’, ‘collaborative integration’ and ‘inventiveness’ as illustrated by figure 4-3. The attributes ‘sense of pride’, ‘trust’ and ‘well-being’ were given over 80% of ‘yes’ responses, so they were part of the second survey round. However, given that ‘inclusiveness’ and ‘joyfulness’ received less than 80% of ‘yes’ responses, they were removed from the framework and the second survey round.

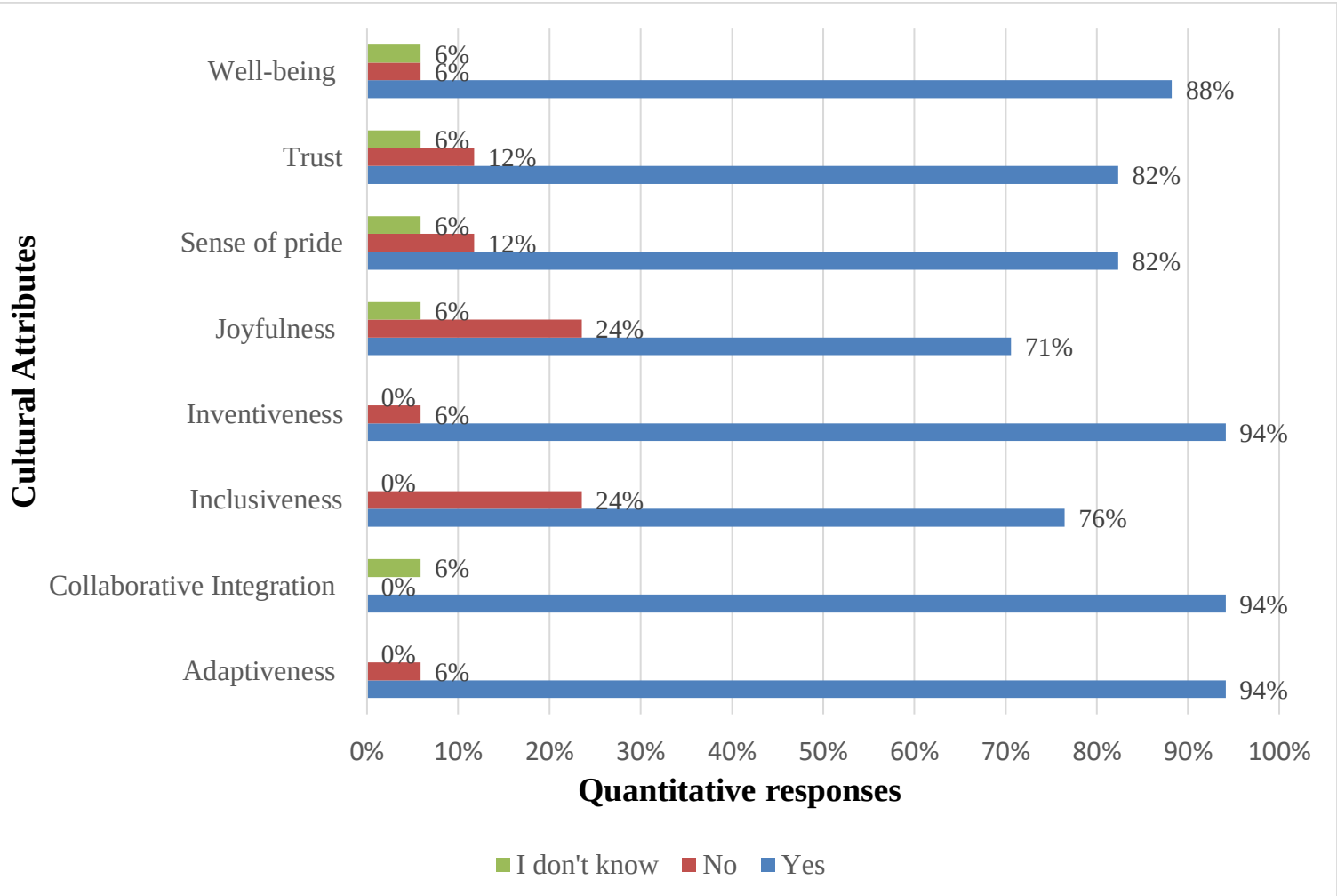


Figure 4-4: Quantitative results on the attributes suitability in supporting OR for the first round, illustrating that the attributes ‘inclusiveness’ and joyfulness’ did not meet the consensus criterion.

4.3.2 Framework survey – Round 2

Following changes to the cultural framework, the participants conducted a second survey. All the modified attributes achieved the consensus criterion. This indicated to researchers that a subsequent round would not be necessary. The ‘adaptiveness’ attribute received 100% of ‘yes’ responses. ‘Inventiveness’ and ‘well-being’ were the attributes with the

second highest ‘yes’ score, followed by ‘collaborative integration’, ‘sense of pride’ and ‘trust’.

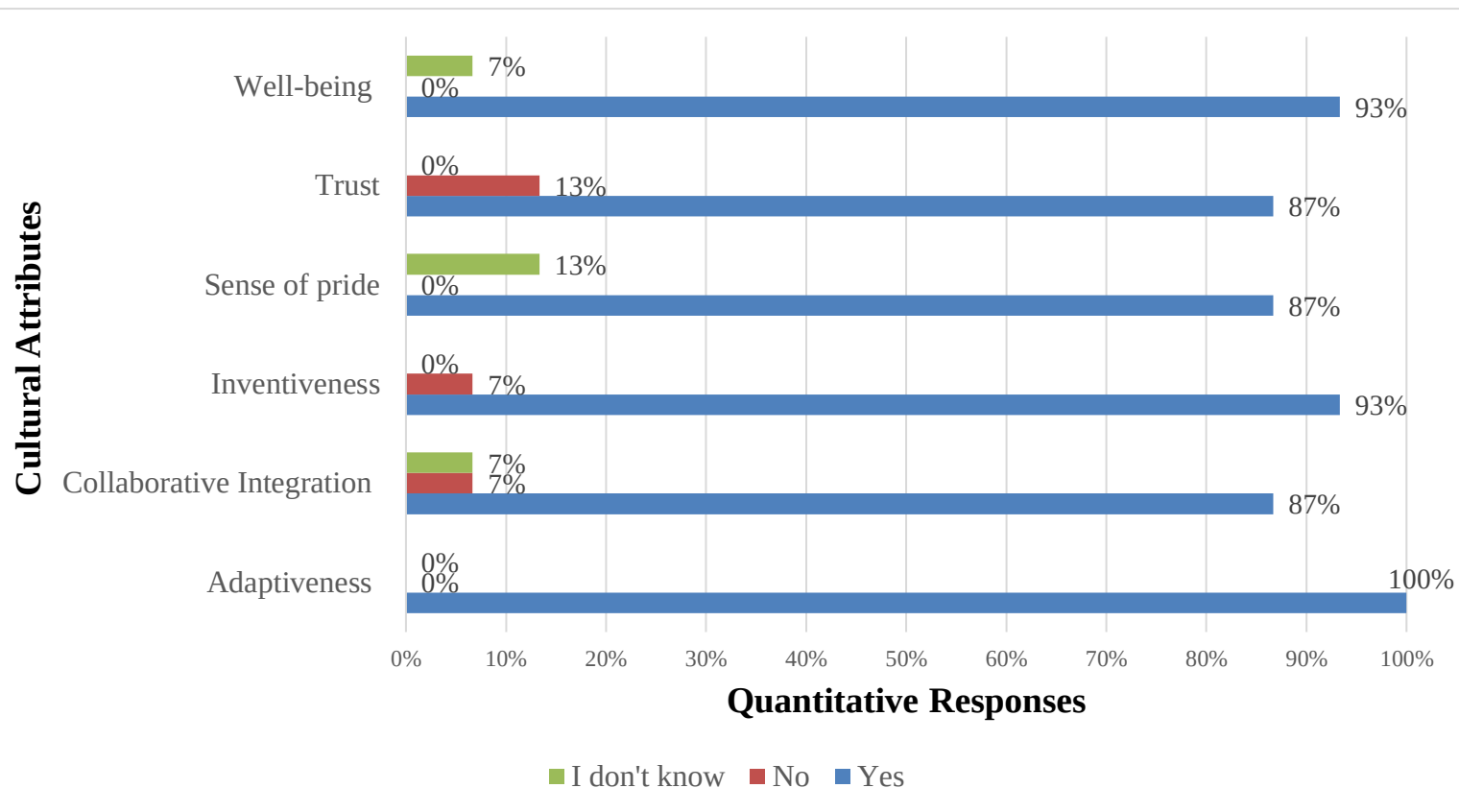


Figure 4-5: Quantitative results on the attributes suitability in supporting OR for the second round which illustrates consensus.

In this round we also asked the participants to nominate the most and least important attributes as shown in figure 4-6.

The majority nominated ‘adaptiveness’ as the most important attribute, followed by ‘collaborative integration’ and ‘trust’. The attributes ‘inventiveness’, ‘sense of pride’ and ‘well-being’ were nominated once as the most important. ‘Inventiveness’ was placed as

the least important attribute, closely followed by ‘sense of pride’ and ‘well-being’. Finally, only one participant responded that ‘none’ of the attributes were least important.

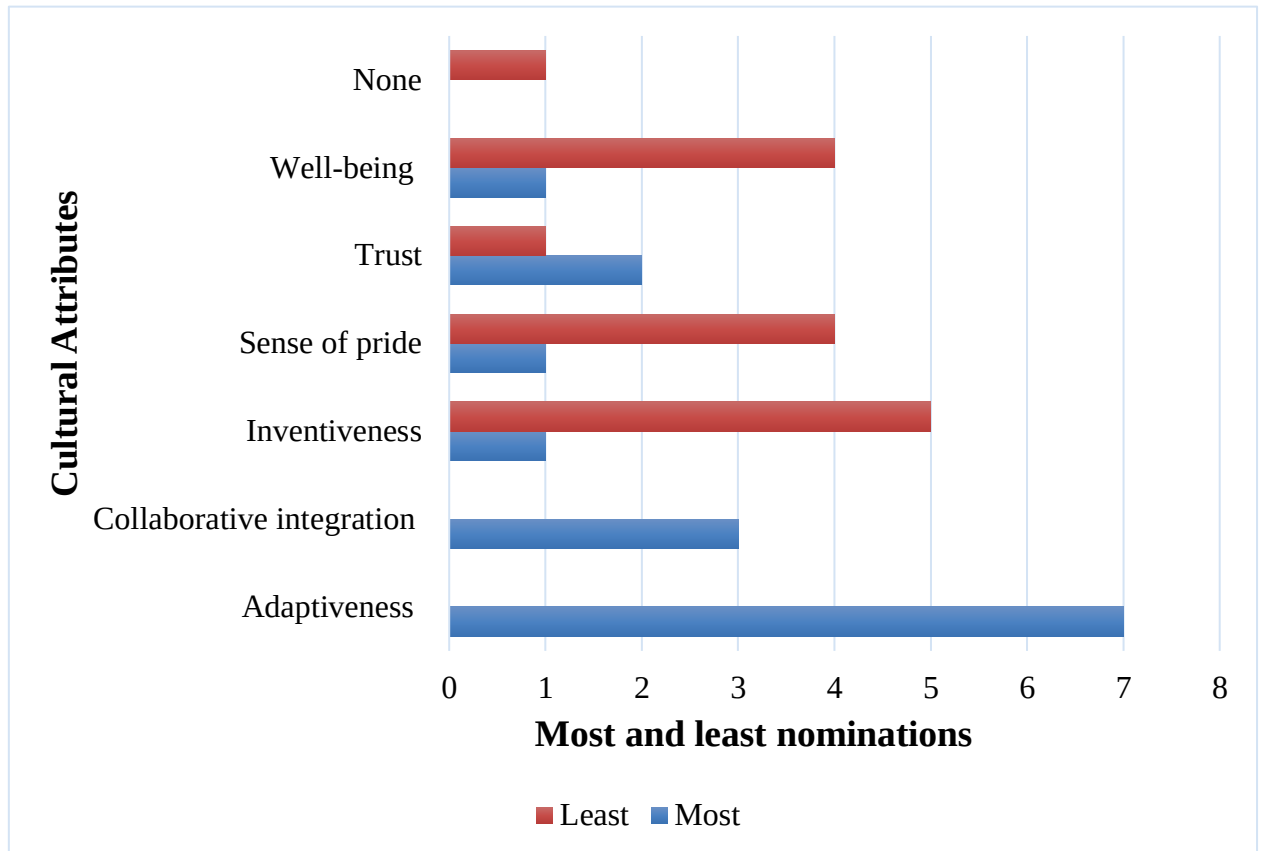


Figure 4-6: Participants’ nomination of the least and most important cultural attributes in support of OR.

4.3.3 Frequent and major concerns for framework refinement.

The themes below, classed as ‘frequent and major concerns’, were utilised to refine the framework given they were composed of suggestions for improvement or challenged the suitability of the attributes’ descriptions.

A key suggestion to the attribute ‘adaptiveness’ was the need to reflect the ‘reactiveness’ element in the attribute’s description: *‘It is the ideal definition of organisational resilience but doesn’t go far enough. It needs to include reactivity to situations as they come up and quick adaptation strategies identified’* (SR03). The ‘learning’ element was also highlighted as an important factor to the ‘adaptiveness’ attribute: *‘It is essential that we learn from the disruptive events that occur and consider how we build learnings from our debriefs’* (SR11).

Including relevant stakeholders was emphasized for the ‘inclusiveness’ attribute as some highlighted the risk of enabling an environment that everyone has the power to veto decisions: *‘Challenge with equal voices is that you drive down to the solutions that everyone can agree [...] You run the risk of everyone having veto power to squash a new approach’* (SR15). We reflected these observations of the need to include relevant stakeholders into the description of the ‘collaborative integration’ attribute for the second round, given that ‘inclusiveness’ did not meet the consensus criteria.

Many comments in support for ‘inventiveness’ were also attached to observations flagging the need to ensure that new solutions are thoroughly assured and proven as safe and effective: *‘Innovative changes must prove to be appropriate before they go full-scale, otherwise it will be risky [...]’* (SR02).

Participants that disagreed with the suitability of ‘joyfulness’ asserted that the benefits of this attribute would not directly contribute to OR and that the variety of personalities in a workplace may hinder buy-in to a joyful culture: *‘[...] the reality is there are many different kinds of people in the workplace, and not everyone responds to cheerful/playful behaviour in a positive way’* (SR12).

Suggestions for the attribute ‘sense-of-pride’ emphasized that confidence of personnel in their own expertise as a key missing element: *‘I would suggest to include: [...] "Individual and collective know-how": staff know what they should do, how to do it why they are doing it’*(SR02).

The comments on ‘trust’ stressed the positives of a supportive environment. The participants flagged that this attribute should not be about ‘whistleblowing’, instead personnel should be encouraged to raise contrasting and contentious opinions, opportunities, and problems: *‘Rather than emphasising on 'Whistleblowing', even though important, the culture is to "Speak Up" to emphasise that everyone's opinion is important and contributes to improvement in organisational resilience’* (SR07).

Finally, significant comments on the ‘well-being’ attribute were made regarding the need to better understand the well-being needs of all employees regardless of seniority and areas in the organisation: *‘So I would say when it is easy to support high performing motivated employees, it happens. But when there is a more difficult situation that impacts large parts of the organisation, they are not always addressed’* (SR17). Some suggestions were also made to merge ‘joyfulness’ with ‘well-being’ which we have adopted in the well-being description for the second round.

4.3.4 Validated organisational culture of OR framework

Based on analysis of the quantitative and qualitative results of the first and second rounds we amended and refined the framework. The final and validated framework is portrayed in Table 4-4.

Table 4-4: Modified cultural framework proposed and validated in the second survey round.

Cultural Attributes	Attributes' refined description
Adaptiveness	The organisation is equipped with a collective mentality and ability to repurpose systems and behaviour as needed, reactively and proactively, to meet challenges, and support learning and improvement.
Collaborative integration	There is a collective drive to share information effectively with relevant personnel and external stakeholders, and integrate different and challenging viewpoints before, during and after decision-making.
Inventiveness	Organisational-wide creativity and experimentation are incentivised, as safe innovative changes are collectively welcomed and perceived as a capability to better adapt to events.
Sense of pride	Individuals across the organisation are confident in their expertise and understand their contribution to the wider organisational objectives. Staff experience a feeling of satisfaction from individual and organisational achievements which are appreciated and celebrated.
Trust	Individuals of all levels feel empowered to speak openly about problems and propose solutions, as concerns and errors are seen as valuable learning opportunities.

Well-being	Professional and personal needs of all staff members are accounted to foment a positive work environment and good staff morale. Employees are supported to look after their physical, mental, and spiritual health.
------------	---

4.3.5 Cross-cutting themes

Here we illustrate three cross-cutting themes identified from all the responses from round 1 and 2. The cross-cutting themes revealed interesting insights regarding how the participants view organisational culture, perceptions on how to shape it towards OR and barriers of doing so.

Culture articulated as standards and procedures

A dominant finding was the association between organisational culture with standards and procedures: *'[...] it is by working together and share data with effective data analytics that we could improve organisational resilience through predictive technology to improve resilience'* (SR07). For instance, when asked about the suitability of the attribute 'collaborative integration' a participant noted the following: *'This is challenging to do, but we are all on one Office 365 platform and have access to central datasets and common systems'* (SR04). The relevance of a cultural attribute in building OR was often corroborated through citing processes, procedures, and standards: *'EU programs require citizen and multi-stakeholder engagement'* (SR08.2). This narrow view gave the impression that if standards and procedures are in place the culture will follow: *'ISO standards are requesting a broader participation and engagement of employees across the organisation'* (SR02).

Organisational barriers

Many participants mentioned organisational barriers that prevented cultural attributes conducive to OR to flourish: *'[...] there is a willingness to collaborate and can sometimes be a structural barrier to achieving successful collaborative culture'* (SR10). The participants underscored several topics, such as structural barriers, excessive bureaucracy, lack of information sharing, politics, financial constraints, narrow focus on efficiency, tensions between professional sub-cultures, and resources constraints: *'There are some very ingrained bureaucratic systems and behaviours that are not easily changed'* (SR17). The remarks on organisational barriers were quite vague, but were found widely: *'[...] Joyfulness is becoming extinct. As we need to become more effective regarding the work to be carried out no time is left for other things'* (SR14). Some comments also presupposed a culture conducive to OR as an aspiration that was overshadowed by more prominent factors: *'It's an aspiration I would not say it's a reality as power, politics and dynamics play their part in ways of working and business culture'* (SR04).

Cultivating recognition beyond financial rewards

The participants emphasised the importance of intangible organisational elements, such as recognition and high staff morale, to foster a feeling of fulfilment amongst personnel: *'The number one factor in job satisfaction is not the amount of pay but whether or not the individual feels appreciated and valued for the work they do'* (SR06). High staff morale, appreciation, recognition, creativity, and inclusion were seen to contribute to less errors, staff-retention, motivation, and commitment: *'Innovation builds the workforce motivation and capability and builds on the desire to improve process'* (SR11). It was suggested that in water utilities financial rewards are not enough to foster strong and long-

term bond with employees: *'Especially in a public utility rewards and incentives other than financial ones are critical'* (SR08). Looking after and engaging employees in a way that they understand the bigger picture and feel proud of a utility's mission was seen to drive long-term accountability of personnel towards more constructive and collaborative behaviour: *'People engage in the big picture rather than simply performing tasks'* (SR02.2).

4.4 Discussion

The framework serves as a reference point to develop an organisational culture of OR. The validated framework reveals - from the perspective of water utility managers - a set of desirable cultural attributes of OR which is a missing endeavour in resilience research for the water sector. In addition, similarly to Georgiadou et al., (2022), it could support the identification of cultural threats for risk and continuity practitioners via the observation of values and behaviours that drastically deviate from the attributes here identified (Dahmen, 2023). The framework could also be utilised as the basis for the creation of an instrument that assess the organisational culture in relation to OR short and long-term.

Whilst the framework illustrated theoretically established characteristics and outcomes, such as continuous learning (Baehler & Biddle, 2018), innovating through experimentation (Farrelly & Brown, 2011) and collaboration (Crick & Bentley, 2020), it has also pioneered cultural features such as positive morale and job satisfaction as relevant for the OR of water utilities, thus indicating enhanced awareness of staff well-being as a contributor to OR performance. The novel grouping of attributes as a framework provides a baseline of an organisational culture of OR, thus broadening

understanding to water sector professionals aiming to align organisational culture with outcomes desirable of OR.

Organisational culture is a significant factor in advancing OR. By linking the cultural attributes with the RAG, we clarify and underscore the importance of human values, assumptions, and behaviour in the path for OR and, ultimately, water sector resilience (Giffoni et al., 2022). If water utilities are to provide sustained water services to society, organisational culture will play a key role in steering the human sentience towards resilient services. This, therefore, calls for continued work in research, policy, and practice in the human and organisational domains, to advance efforts that embrace and incentivise cultural and organisational initiatives aligned with OR. Finally, the attributes were drawn from a variety of disciplines, thus highlighting the framework's relevance to different sectors and the importance of cross-pollinating from a variety of research fields to broaden perceptions on organisational culture and OR.

Refined model of organisational culture. The three-level model of organisational culture by Schein was modified in this study. We argue that not all artefacts are underpinned by underlying assumptions as posited by Schein & Schein, (2017). Artefacts encompass observed and feelable behaviour, structures, and processes. However, structures and processes may manifest as superficial artefacts that are aspirations, but are not necessarily fully embedded in the underlying assumptions of the organisation. These 'superficial artefacts' may be manifested as written strategies, charters, and annual reports but not actually part of the organisational culture. Our argument, that artefacts as structures and processes may also fall under ideologies, is lightly discussed by Schein & Schein (2017), but are not reflected in the three-layered model. Based on this, we

separated artefacts into two to enhance clarity of the analysis; (1) artefacts as structures and processes; and (2) artefacts as behaviour.

Proactiveness and reactiveness towards OR. A notable finding in the ‘adaptiveness’ attribute was the importance of ‘reactiveness’ when adapting to events. A reactive conduct is often downgraded in resilience literature which is attached by a connotation of being outdated and an unfit approach, thus giving precedence to pro-active principles as a more mature capability (Hamel & Valikangas, 2003; Pollard et al., 2013; Summerill et al., 2011). Not all potential scenarios can be foreseen and prepared for through proactive efforts, as ultimately, organisations may be faced by unprecedented events that may require reactive capabilities (Hollnagel, 2014). Additional investigation is needed on how to concomitantly advance both – proactiveness and reactiveness - to boost adaptiveness; such as augmenting well-rehearsed/pro-active behaviour that is unexpectedly challenged by sudden shocks and identifying values that enhance the efficacy of reactive responses.

Collaborative integration as a normative value. Even though ‘collaborative integration’ was perceived as one of the most important attributes, we argue that it may not be socially proven as effective in a utility setting, especially given the highlighted ubiquity of organisational silos in critical systems and the water sector (Brown et al., 2017; Chalker et al., 2018; Giffoni et al., 2022). Challenges around silos reported in literature, may be due to ‘collaborative integration’ being espoused as a value driven by a normative frame, but has not been fully absorbed as an underlying assumption that translates as daily organisational behaviour (Schein & Schein, 2017).

Risk-averse culture as an ongoing roadblock to inventiveness. Whilst the quantitative scores were in favour of ‘inventiveness’, the attribute was nominated the least important

in building OR. In qualitative responses ‘inventiveness’ was perceived as secondary to sustaining the reliability of water services; a tension increasingly discussed in literature (Biddle & Baehler, 2019; Chester & Allenby, 2019; Crick & Bentley, 2020). The findings’ consistency with theoretical debates, on documented frustrations to push ‘inventiveness’ beyond a risk-averse culture (Farrelly & Brown, 2011), reinforces timeliness of this challenge and the need to nurture inventiveness as a key cultural value in water utilities. Long-term implications may be manifested as an inability of water utilities to develop novel capabilities to address new and gestational challenges internally and externally.

4.4.1 Broadening perspectives on organisational culture

Underlying assumptions as overlooked cultural capabilities. We observed a tendency from participants to perceive organisational culture as standards and procedures or that by adopting certain processes the desired organisational culture of OR would follow. In Schein & Schein’s layered model this is represented as artefacts encompassing ‘visible and feelable structures and processes’ (Schein & Schein, 2017 p. 18). These perceptions hint that water professionals may be focusing on tangible elements without much consideration of underlying assumptions that directly shape personnel’s behaviour. Given that the participants are immersed in a technical environment influenced by engineering perspectives (Akamani, 2016; Omar et al., 2017), they may prioritise concrete and tangible interventions to shape the organisational culture. Reflecting on our sample, composed of managers and senior managers, we argue that leadership may be relying on standards and procedures without accounting culture’s abstract complexity.

As such artefacts (structures and processes) may be seen as the main vehicle to ingrain values and beliefs conducive to OR (Biggs et al., 2013). In contradiction, some studies assert that one cannot ‘implement culture’ (Graamans et al., 2021) given its evolving nature (Schulman, 2020), and that is shaped by ‘bottom-up’ assumptions and values that are proven as effective over-time (Bisbey et al., 2021) through leadership (Biggs et al., 2013; Summerill et al., 2010), and collective external adaptation and internal integration (Schein & Schein, 2017).

Managers and senior-managers must acknowledge the importance of values and beliefs and, especially underlying assumptions, in order to steer the culture towards OR. Utilities’ leaders should accommodate more intangible cultural interventions and embrace the iterative process it entails through: (1) accounting the current organisational cognitive frame, unconscious rationalisations and how societal factors may impact the organisational culture; (2) attain better understanding of the organisational barriers in the way of a culture conducive of OR; (3) establishing leaders as change agents and role models of the ‘desired culture’; (4) attain organisational consensus on the effectiveness of espoused values and beliefs in practice. Figure 4-7 showcases the perceptions of participants of how to develop an organisational culture of OR and illustrates Schein & Schein's, (2017) process in support of transitioning to an organisational culture of OR.

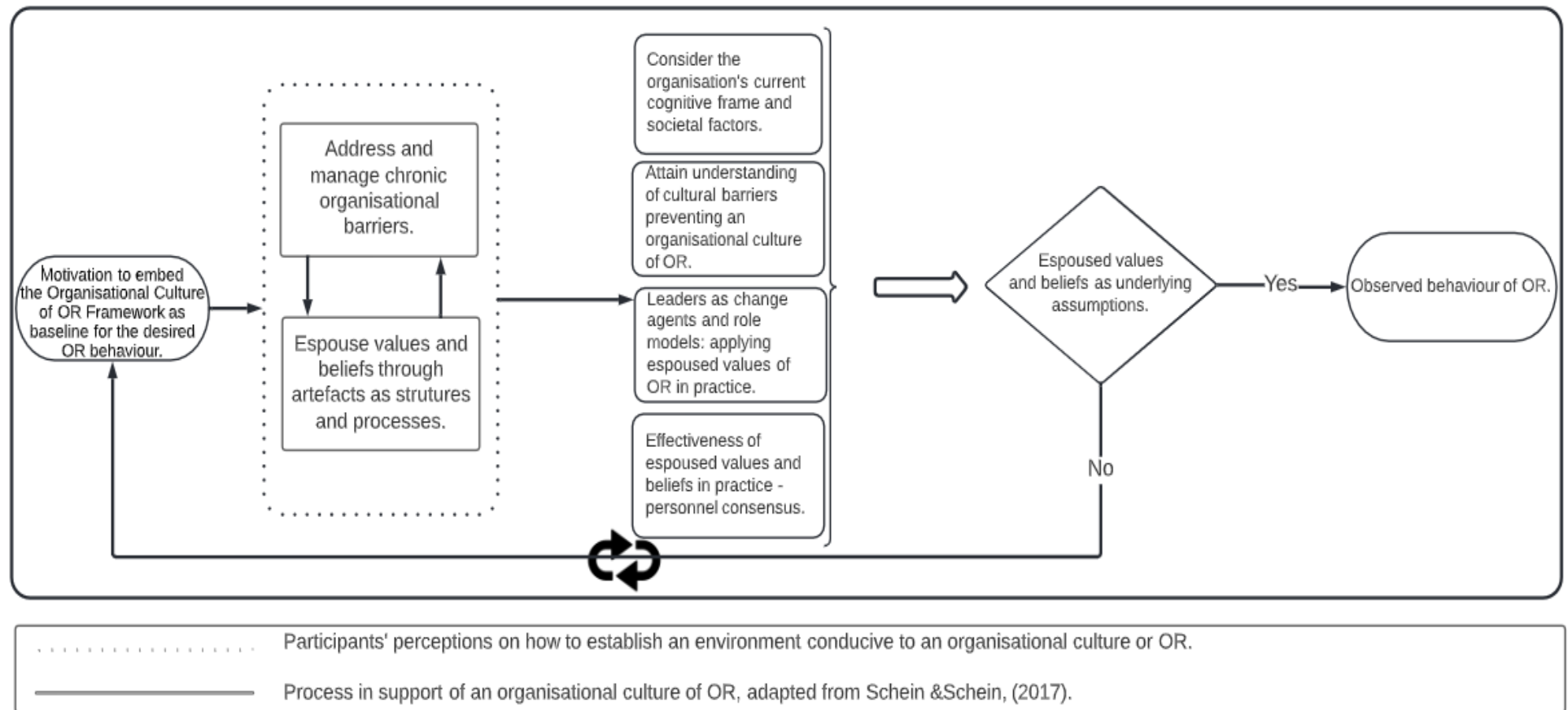


Figure 4-7: Current perceptions on how to shape the organisational culture towards OR in water utilities and the process in support of an organisational culture change in support OR, adapted from Schein & Schein (2017).

Misalignment between the desired behaviour of OR and the observed behaviour.

Espoused values and beliefs that do not align with underlying assumptions of personnel tend to present as ideological aspirations for the future which may fail to manifest as the ‘desired behaviour’ (Schein & Schein, 2017). This brings to light the significance of values and beliefs also being socially accepted and reliably proven as effective in practice, instead of just structurally imposed (Alvesson, 2002). Therefore, given the perceptions of culture as standards and procedures, this reflects a potential disparity between the ‘desired behaviour’ aspired from leadership and what is happening on the ground as ‘observed behaviour’ (Schein & Schein, 2017). Initiatives to change organisational culture towards OR within utilities, stemming from standards and procedures, may not impact the underlying assumptions of personnel thus preventing positive behaviour change.

Need for pragmatic and responsive approaches to embed an organisational culture

of OR. Reflecting on the fast-paced nature of emerging trends affecting water utilities, which compels the development of responsive and adaptive organisational mechanisms (Chester & Allenby, 2019), we question the responsiveness of the cultural change process proposed by Schein & Schein, (2017). Utilities may have to heavily draw from and develop the ‘adaptiveness’ attribute to swiftly accommodate cultural-changing needs demand-led by an ever-changing environment. Future work should identify pragmatic ways to enhance responsiveness when re-configuring an organisational culture that is able to catch up with dynamic demands affecting water utilities.

4.4.2 Anchoring an organisational culture of OR

Need for a resourceful approach to cultural changes. The participants noted that organisational barriers, such as organisational politics and resources constraints, may prevent an organisational culture of OR to emerge or may need to be firstly addressed prior to efforts to develop an organisational culture of OR as seen in figure 4-7 above. However, organisational barriers are part of organisational life (Summerill et al., 2010), therefore we argue that inaction until organisational barriers are addressed may further hamper the development of an organisational culture of OR. Especially because organisational culture has an intrinsic link with decision-making, habits, and norms (Alvesson, 2002) which are important enablers or remedies to the organisational barriers noted above. Whilst addressing all organisational barriers may not be feasible for utilities, a more targeted approach may be more appropriate.

Accordingly certain initiatives could be actioned, including consulting with wider personnel critical areas in need of cultural change in support of OR to target initiatives with the highest impact and ease of being implemented (Biggs et al., 2013). Furthermore, utilities can overhaul organisational policies to ensure coherence with OR strategies, behaviour, and values (Harrison et al., 2017), identify tailored ways to transmit the importance of the ‘desired culture’ of OR to different sub-cultures (Schein & Schein, 2017), and, finally, leaders can initiate cultural changes by leading by example to cement OR principles as underlying assumptions across personnel (Summerill et al., 2010).

Similarly, according to Schein & Schein, (2017) and as seen in figure 4-7, organisations should acquire support from leadership on any endeavour related to the organisational culture to foment the motivation for a culture change. Although organisational barriers

may exist and cannot always be completely addressed, utilities should identify resourceful ways to develop an organisational culture of OR based on their unique organisational environment that is predominantly focused on physical assets to ensure reliability in a context of resource constraints.

Managing resourcing challenges through a culture of OR. The theme about recognition of personnel beyond financial rewards, indicated an appetite to move away from a transactional relationship with employees. Instead, it was noted a need to stimulate closer ties between the staff and the organisation through relational channels that recognises job satisfaction and high-staff morale (Lengnick-Hall et al., 2011). Although, this theme contradicts with the emphasis on artefacts as structures and processes noted above, perceptions on augmenting intangible relational ties with personnel derived from a very tangible challenge of organisational resourcing. In order to attract and retain talented individuals as well as reduce staff turnover – factors noted as an OR challenge for the water sector (Baker et al., 2018; EUM, 2016) – utilities must attend to new societal trends, such as supporting work/life balance, intellectual stimulation, and a positive and pleasant work environment (Malinen et al., 2019).

High-staff turnover can impact institutional memory of lessons learned to effectively deal with shocks and stresses (EUM, 2017) and may lower productivity (Mahmoud & Rothenberger, 2019), therefore incurs additional costs. These negative impacts are felt more acutely by water utilities as they must recruit and retain high-skilled professionals in a backdrop of distinctive challenges, such as limitations in offering competitive salaries in public utilities, aging workforce, lack of resources, changes to workforce dynamics due

to novel aspirations of younger generations, and ongoing issues with effective knowledge management (EUM, 2016; Giffoni et al., 2022).

The need for nurturing staff recognition, satisfaction and high-morale tied closely with ‘sense-of-pride’ and ‘well-being’ attributes in the framework. However, this theme was devised from cross-cutting data, thus indicating that these benefits may also rise collectively from the whole framework, rather than from a single attribute. To our knowledge, literature often associates staff recognition and satisfaction with individual cultural attributes (Arnett et al., 2002; Mas-Machuca et al., 2016), without much consideration on how a collective set of cultural attributes, may support the retaining and recruiting of talent. Future work should assess how the application of our framework and the development of a culture of OR may alleviate this resourcing challenge in the water sector.

As observed above, water utilities’ professionals tend to focus on artefacts when articulating about organisational culture. Therefore, expanding initiatives towards developing intangible cultural capabilities will be crucial to address resourcing challenges. Utilities can start by fomenting a positive and intellectually stimulating environment where employees’ contribution is understood and coherently associated with strategic objectives, and the significance of staff well-being is meaningfully recognised and applied in practice.

Although recognition exist on the benefits of developing stronger relational ties with personnel, little was articulated on exactly what interventions are required, how to implement them and the potential challenges of doing so. An organisational culture conducive to talent recruitment and staff retention will however need to be better

understood through a consultation with water sector professionals on their preferences and aspirations. By clearly understanding the unique conceptualisations of water sector professionals relating to their expectations of a positive work environment and professional prospects, can utilities manage this growing resourcing challenge in the water sector.

4.4.3 *Study Limitations*

The validation of the framework does not account wider elements that directly influence organisational culture, such as nationalities, regional customs, occupational background, and previous exposure to threats. Future work should consider these factors that influences people's underlying assumptions, thus facilitating change towards an organisational culture of OR. Although our study focused mainly in the organisational culture, we could not provide a detailed picture of how the external cultural context may have impacted individuals' perceptions of the attributes here proposed. Due to COVID-19 restrictions the researchers were not able to immerse themselves into the utilities' daily life through ethnographic work, therefore, our themes here portrayed are by no means comprehensive. However, they do provide a snapshot of some cultural tendencies in water utilities. Furthermore, we recognise the importance of capturing the perceptions of frontline workers, especially on how culture is transmitted and interpreted and how this relates to a 'desired' organisational culture of OR. Undeniably, organisational culture could play an important role in overcoming organisational challenges (Alvesson, 2002), however expanding the granularity of our framework in a way that's is tailored to individual utilities will be needed to address idiosyncratic challenges of water utilities immersed in different internal and external environments.

4.5 Conclusion:

This study improves knowledge on the links between OR and organisational culture for the water sector. By utilising a modified Delphi approach, we validated a novel framework by capturing the perceptions of water utilities managers on desirable attributes and outcomes of organisational culture for OR. Here we responded to the under-investigation of cultural characteristics conducive to OR (Giffoni et al., 2022; Smith et al., 2019; Tang et al., 2013; van der Merwe et al., 2018) by linking cultural attributes derived from relevant literature with the RAG (Hollnagel, 2011). The final framework attained consensus that was corroborated by qualitative responses from water sector professionals, thus illustrating consistency in the results and validation process.

The framework here devised serves as baseline on cultural attributes conducive to OR, may support in the prevention and identification of cultural threats and as the basis for the creation of an instrument to assess an organisational culture short and long-term.

The cross-cutting themes added additional depth to current perceptions as we provided an initial understanding on how culture is perceived and aspired, as well as some organisational barriers to organisational culture change in water utilities. Here we also relate the findings with Schein & Schein's, (2017) adapted structural levels of culture to clarify the dynamics and interactions of different elements that compose organisational culture in the context of the water sector. The framework serves as a steppingstone towards understanding the relationship between organisational culture and OR to scholars and practitioners and sets the scene for future research on organisational culture of OR for the water sector.

Through the structural levels of culture from Schein & Schein, (2017), we evinced a snapshot of how organisational culture may be perceived and aspired by leaders in the water sector. A tendency to focus on artefacts to achieve the ‘desired’ behaviour was identified, which we argue may be associated with the technocentric professional background reflecting in the underlying assumptions of leaders. Leaders may surmise that if appropriate artefacts as structures and processes are in place the ‘desired behaviour’ of OR will be achieved. This is problematic because the process of shaping the organisational culture to embed OR values also entail intangible interventions through an iterative process that accounts the organisational cognitive frame, societal factors influencing culture, identification of barriers to the ‘desired culture of OR and motivating leaders as role models to drive consensus on the proven effectiveness of OR espoused values and beliefs in practice.

Organisational barriers should not impede advancing efforts towards an organisational culture of OR. Utilities should initiate resourceful initiatives that can pave the way for the desired organisational culture. For instance, leadership should be brought in on the need for culture change to support an effective assessment of the current culture to attain understanding of barriers that specifically conflict with an organisational culture of OR, thus facilitating a more targeted and optimised approach.

Finally, although recognition exists on the benefits of developing stronger ties with personnel through social measures focused on recognition and well-being to manage resourcing challenges, little is known about the preferences of personnel, and what cultural interventions are appropriate to promote an environment that produces staff satisfaction. We advise extending the granularity of the framework here produced in a

way that is tailored to individual types of utilities (public and private) from different regional contexts and resilience maturity.

4.5.1 *Considerations - Delphi method*

Whilst the Delphi method advises the recruitment of real-world experts on a specific phenomenon as an appropriate sample (Brady, 2016), guidance is scarce on how to manage stubbornly ingrained perceptions from the participants - namely culture as artefacts as structures and processes - that conflicted with the scholarly-accepted definition of culture. For instance, even though a definition of organisational culture (Schein & Schein, 2017) was stated in the beginning of the survey as a baseline for reflection, some of the participants' responses were inconsistent with the proposed definition. Some comments and suggestions were overtly focused on corporate procedures and standards, without much consideration of the intangible elements of culture. This tension demanded the researchers to have extensive discussions around interpreting the requested changes in a way that was consistent and encompassed all the different elements of organisational culture.

5 Conclusion

This thesis brings to light a fresh perspective on resilience for the water sector by extensively exploring the organisational and social domains of water utilities in relation to OR.

Although the findings derived from a non-generalisable sample, the results provide fresh observations, broadened understanding on the different conceptualisations of OR and the particular challenges and opportunities to building OR across different international utilities (Tsoukas, 2009; Buchanan & Denyer; 2013).

The themes derived from this research highlight the multifaceted challenges of building OR from the perspective of water utilities' managers as well as untapped opportunities for developing OR through customers and organisational culture. Some key challenges, such as transitioning from a fail-safe to safe-to-fail stance in the human and organisational domains reinforces that water utilities are predominant mechanistic underpinned by robustness and rigid approaches and values. This is particularly exemplified by the themes: 'narrow' understanding of resilience', 'constrained environment for innovation' and 'resilience and resources' in chapter 2, and 'culture articulated as standards and procedures' in chapter 4. However, other themes also evinced an appetite to unlock OR capabilities, such as 'lack of understanding on how to embed a culture of OR' in chapter 2, the themes in chapter 3 that acknowledged the need of greater engagement to maximise

the roles of customers in OR and chapter's 4 theme on the need for greater meaningful recognition of staff through 'cultivating recognition beyond financial rewards. The sum of the themes, provide the overarching insight that water utilities are still 'locked-in' on fail-safe values and approaches, but there is an impetus for greater flexibility and adaptability to be leveraged in the social and organisational domains. Therefore, there is a willingness to develop OR properties – cognitive, behavioural and contextual – but there are some structural (resources) and cognitive (values and beliefs) factors in the way of OR development in water utilities.

This final chapter provides a summary of the key findings identified and responds to the research questions by further elaborating on the implications of the challenges and opportunities of building OR captured from water utilities' managers. Furthermore, this chapter illustrates some implications to policy, the water sector, methodological novelty, and advises on areas of future research.

5.1 Summary of findings

5.1.1 Exploring the human dimensions of resilience within the water sector

Chapter 1 underscores the importance of investigating the human dimensions of building resilience for the water sector due to the over-focus of striving for resilience based on mechanistic approaches towards hardening physical assets. This is problematic because humans give the sentience to physical assets to prevent, manage and recover from disruptive events. In addition, as shocks and stresses become more complex, inevitable, and wider in their reach, therefore, water utilities are compelled to embed not only the

traditional reliability stance of preventing failures, but also to forge adaptiveness and flexibility into their systems. As observed in literature augmenting adaptiveness and flexibility can be assisted by aligning organisational dynamics, culture, and relationships with principles of OR (Denyer, 2017; Gover & Duxbury, 2018). In view of this, the concept of OR by Lengnick-Hall et al., (2011) is applied to this research due to its ability to cover organisational dynamics, organisational culture, and internal/external interactions with stakeholders.

Although literature flags the need for theoretical advancements in the human dimensions of resilience within water utilities, very little is known about the organisational challenges that stand in the way of building OR due to a dearth of empirical studies. Even more scarce, are studies that examine the organisational culture of water utilities in relation to OR as well as the role of stakeholders in building OR in partnership with the water sector. As noted above, most resilience studies in the realm of the water sector are centred on the strengthening of the robustness of assets through the prevention of failure and reduced downtime from specified threats, e.g.: floods, droughts, and contamination. Furthermore, current literature that applies OR are often prescribed frameworks and they lack depth of understanding on the realities of organisations. In addition, there is a lack of OR studies in the water sector, specifically studies that delve deep into the organisational environment, culture, and interactions with customers.

5.1.2 Transitioning to an organisational environment of OR

Following appraisal of literature, Chapter 2 examined the current organisational environment of international water utilities through the lenses of the of an analytical framework with organisational properties of OR (Lengnick-Hall et al., 2011). Semi-

structured interviews with water utilities' managers were identified as an appropriate method to capture in-depth insights of the challenges and opportunities to building OR. Through the application of thematic analysis, this chapter revealed predominant challenges hampering OR within the cognitive, behavioural, and contextual properties of water utilities. Furthermore, organisational culture and the involvement of customers are reinforced as under-explored areas for the resilience of the water sector.

The key findings of chapter 2 are summarised below:

The narrow perceptions of resilience by practitioners, based on reliability and risk management, indicated a need to broaden perspectives to account other key concepts, such as flexibility and adaptiveness. Similarly, utilities' over-focus on efficiency and short-term issues was driven by contextual constraints of scarce resources. This indicated an initial insight that water utilities may not have the resources to develop their behavioural reserves to better manage different disruptions. Likewise, utilities currently rely on traditional risk-averse and reliability behaviours to sustain functionality, therefore, a new argument emerged regarding their under-developed ability to manage paradoxical tensions of applying contrasting behaviours when needed. This was exemplified by the concentration of efforts by utilities on tried and tested approaches without a propitious environment to experiment with innovative solutions.

Three categories of silos were identified for the first time in an OR study for the water sector: physical, technical, and hierarchical. As a dominant theme across the participants, this denoted that utilities may experience difficulties in forging strong resource networks

and social capital internally; across teams managing assets located in different regions, personnel of varied technical expertise teams and hierarchies.

A lack of explicit commitment from leadership on resilience was associated with a contextual deficiency that impacted utilities' ability to implement a long-term resilience strategy. Given that resilience requires resources to develop its contextual capability (Lengnick-Hall et al., 2011), water tariffs was dominant topic. For instance, lack of leadership commitment was also associated with reluctance to increase water tariffs due to efforts to shield customers from having to foot higher bills and the detrimental political repercussions. Therefore, attaining socio-political buy-in and commitment to resilience investments was flagged as crucial to ameliorate utilities' current resource constrained environment.

The findings also extended OR theory which posits that resilience should be the responsibility of all members of the organisation (Denyer, 2017). Instead, the findings indicate that utilities should embed a central structure that is responsible for driving and sustaining OR in utilities as well ensuring that personnel across the organisation also are committed and share the same values and beliefs of OR.

Finally, the theoretical significance of organisational culture in developing OR (Baker et al., 2018; Brown et al., 2017), was not reflected in practice. Recognition of the importance of culture was widespread, but without a clear understanding on how to build a culture conducive of OR. However, a novel set of cultural attributes conducive to OR was identified. The attributes were utilised in the remainder of this research as an initial step towards a new framework of an organisational culture of OR.

Chapter 2 therefore contributes to the aim as it addresses the objective 2: *‘To capture the perceptions of water utilities’ representatives regarding the current challenges and opportunities in developing organisational (internal) capabilities conducive to OR principles’*.

5.1.3 Collaborating with customers towards OR

After a careful examination of the organisational dynamics (chapter 2) in water utilities, this study introduced some novel insights on the customers’ role in building resilience for the water sector. Whilst this study confirmed assertions from literature on the importance of customer collaboration with utilities as crucial for resilience (Baehler & Biddle, 2018), the findings suggested that positive collaboration and co-creation of resilience with customers is heavily dependent on effective engagement initiatives by utilities.

Perceptions of participants on the intent of customer engagement extended current discourse of resilience literature. Literature predominantly elaborates on the role of customer engagement as a vehicle to support the protection of customers’ interests in resilience investments (Ananda et al., 2022; Hendry, 2016). However, the findings were explicit that customers could be cast as key agents in building resilience with water utilities short and long-term.

Effective customer engagement was seen to require better understanding of targeted and pragmatic approaches, with the participants elaborating on their preferred or ideal method of engagement. As such, it was identified across the findings a set of interventions that were perceived to support effective customer engagement which were not previously identified as a group of interventions for the resilience of the water sector, such as: 1)

simple and relatable language; (2) continuous communication and engagement; (3) educational and interactive initiatives; (4) identification of commonalities and management of trade-offs; and (5) tangible and intangible incentives for collaboration.

The participants were quite emphatic that water utilities by themselves cannot ensure resilience, as resilience challenges were seen as societal. For instance, the need for nurturing deep social capital with customers was also a new insight, which was based on establishing a support network where customers are collaborative partners before, during and after a disruptive event and aware of the complexities in sustaining functionality experienced by utilities.

Customers were seen to support decision-making towards effective infrastructure planning, thus specifying the need and targeted intervention towards addressing a crucial theoretical question of ‘resilience of what to what?’. Furthermore, the participants viewed customers as drivers of innovation and experimentation through customers’ strong support for SUDS which is an emerging solution, though its effectiveness and reliability has not been fully tried and tested.

Diversifying perspectives by capturing the opinions of different demographics was seen to assist the assessment of wider trade-offs and flag potential disruptions derived from unintended consequences. Such approach was viewed as a more comprehensive way to read the external environment utilities must navigate towards general resilience.

Resource constraints flagged by utilities from lower-income countries coupled with a lack of literature informing customer engagement based on their realities, were major road-blocks in developing a more proactive and effective approach to customer engagement.

Lastly, resilience from the level of individuals through enhanced preparedness and coping capacity can have positive repercussions to utilities adaptiveness. Similarly, the buy-in from individuals in resilience strategies can have a cumulative effect through social advocacy that pushes political and governmental leaders to be in favour of resilience initiatives. Therefore, the link between the micro and macro resilience has not been fully leveraged and is an untapped opportunity for water utilities.

Chapter 3 therefore contributes to the aim as it addresses the objective 3: ***‘To capture the perceptions of water utilities’ representatives regarding the current challenges and opportunities in developing social (external) capabilities conducive to OR principles.***

5.1.4 Advancing understanding of an organisational culture of OR

Having gained an initial clarity on the relevance of organisational culture in building OR in chapter 2, chapter 4 unfolds the respondents’ perceptions of desirable attributes of a culture of OR for the water sector. Through the appraisal of current literature relevant to OR and a modified Delphi approach, this chapter devised the first organisational culture of OR framework for the water sector. The framework is composed of six cultural attributes: adaptiveness, collaborative integration, inventiveness, sense of pride, trust, and well-being. The model of organisational culture by Schein & Schein, (2017) is applied to assess the findings derived from the framework validation process. The attributes are also related to the RAG framework, thus providing a methodical clarification of the relationship between the attributes identified and resilience. The framework provides some practical guidance to utilities in aligning their current organisational culture with a culture of OR.

From the findings, the underscored importance of reactivity contradicted the predominant stance from resilience literature of proactiveness being a more mature capability (Erol et al., 2010; Lee et al., 2013; Sawalha, 2015), thus expanding views on the importance of effectively applying and developing both reactive and proactive behaviours. Elsewhere, the dominant support on the suitability of ‘collaborative integration’ is contradicted by chapter 2 who flagged the pervasiveness of silos, thus showcasing a disparity between aspiration of utilities’ managers and the reality in water utilities. Similarly, contradiction was also identified in the results of the ‘inventiveness’ attribute. Whilst ‘inventiveness’ was strongly supported in quantitative results, it was nominated the least important attribute, thus confirming theoretical views that a risk-averse culture still overpowers the ability to innovate in water utilities.

Empirical evidence suggested a simplified perception of culture by the participants that is centred on standards and procedures as the main drivers of an organisational culture of OR, without accounting intangible elements of culture such as underlying assumptions, and values and beliefs. Therefore, showcasing a view that is misaligned with theory (Schein & Schein, 2017), given that artefacts - as structures and processes - were seen as the basis to developing an organisational culture of OR. Whilst organisational culture is underpinned by intangible structures (values, beliefs, and underlying assumptions), creating a culture conducive to OR in utilities may be hampered by the current culture that concentrate efforts into initiatives that deliver palpable and visible changes as opposed to shaping and validating values and beliefs to promote lasting changes. Therefore, utilities may be attempting to change the current culture towards OR through the misconception that cultural changes can be enacted simply through standards and

procedures. This indicated an aspiration/reality disparity between the ‘desired behaviour’ of OR – that predominantly encompasses social and organisational capabilities - and the ‘observed behaviour’ that occurs in water utilities, given the current drive for more tangible and technical outcomes.

Although some participants believed that organisational barriers (notably resource constraints and internal politics) must be firstly addressed to then focus on refining the organisational culture towards OR, chapter 4 chapter 3 argued that pragmatic efforts must be put in place to gradually mould the organisational culture towards OR. Especially because permanence of the cultural *status quo* could prevent advancements in remediating the identified organisational barriers.

In contrast with the perceptions by the participants that culture is built through artefacts (structures and process), chapter 4 also evidences an inclination to build a culture that by utilities’ managers to build stronger ties with personnel to ensure recruitment and retention of talent. Documented staff resourcing and remuneration(Zaato & Ohemeng, 2015) challenges in the water sector, such as high staff turn-over (EUM, 2016), appeared to be the main driver for a strong desire to invest in staff well-being and augment social ties to ensure retention of staff and promote an appealing environment for newcomers. However, not much was elaborated on how to promote a cultural environment that support talent retention and recruitment, thus further work is necessary to capture aspirations and preferences of water professionals.

5.2 Challenges and opportunities to embedding OR

This thesis showcases key insights on fields (social and organisational) that have been under-explored in literature and practice. It does so by identifying the challenges and opportunities within the organisational and social realms as well as exploring attributes of an organisational culture conducive to OR across different regional realities.

5.2.1 *Implication of challenges:*

Through chapter 1, it was identified key knowledge gaps that underpinned the remainder of this study. For instance, organisational and social capabilities for resilience in the water sector have not been fully explored in theory and practice and utilities could capitalise from these capabilities to prepare for and manage future disruptions more effectively. Emphasis was given to better unpick the linkages of the organisational culture and behaviour in utilities as well as interactions with external stakeholders and relevance to resilience. However, the technocratic stance of water utilities may prove as a challenge to adapt current organisational and social dynamics to truly embed OR principles and behaviour. Especially, because such capabilities challenge internal perceptions through their intangibility in comparison to more tangible initiatives to physical assets that are often focused on preventing failures to occur (fail-safe). These challenges identified in literature influence the propensity of utilities to fundamentally embed more adaptable and flexible capabilities (safe- to- fail) and recognise that capabilities in the human domain are equally as important to the physical environment.

The empirical work conducted in this study confirms the findings in literature and provide novel insights on the realities of a water utility environment in relation to OR. This work

underscores significant challenges to the cognitive frame in utilities (chapter 2) that is further reinforced by the cultural findings (chapter 4) where the values and beliefs of utilities' representatives tend to favour more tangible and mechanistic efforts to build resilience, as opposed to welcoming softer capabilities that can foment a safe-to-fail environment to complement the sole focus of robustness. Such cognitive challenge is problematic because established values and beliefs directly impact behaviour, the disposition to experiment with new solutions and prioritisation of what is important for the resilience of an organisation. Therefore, utilities must broaden views on resilience to account human-based capabilities that foments adaptiveness and flexibility as well as embedding such views in the organisational culture.

Resource constraints was a cross-cutting-theme across the empirical papers. Although lower-income utilities seemed to be impacted more drastically by lack of resources (Zaato & Ohemeng, 2015) – low quality of service and inability to have the resources to even initiate the resilience agenda - all utilities were quite vocal that the current scenario is not fully conducive to effectively put in place resilience initiatives that overhaul the organisational culture, expands the behavioural reserves of personnel, and enable proactive and meaningful customer engagement. In chapter 4 resource constraints were flagged within a cross-cutting theme which was seen as a direct barrier to making positive changes to the organisational culture. As a contextual element that underpins the cognitive and behavioural capabilities of OR, utilities will have to be ingenuous and resourceful, coupled with support from stakeholders, in order to make positive changes whilst immersed in an environment that is stretched for resources.

Another key challenge is the uncertainty on leadership commitment for resilience. Leaders not only establish the desired values and beliefs within organisations, but they are role models that set example through the consistency of their daily actions with the strategic objectives and peer to peer interactions. Therefore, lack of an overt commitment from leadership, as noted in chapter 2, have drastic influence on the organisational culture that gives rise to behaviour and the organisational dynamics (Biggs et al., 2013; Summerill et al., 2010). If utilities are to make changes to their organisational culture, as proposed by chapter 4, leadership will have to be the driving force to push such a long-term change. It should be noted that public utilities, which are more likely to be influenced by the changing political scenario, will need to establish stability mechanisms to ensure consistency of their strategic direction of travel.

Establishing an organisational culture of resilience (chapter 4) that cuts across the organisation, will require significant advancements in the bridging of organisational silos. Particularly because the more isolated and static silos are in organisations, the more likely that the different sub-cultures will sustain and develop contrasting views of organisational objectives (Schein & Schein, 2017) also noted in the findings from Summerill et al., (2010).

As observed in chapter 2 lack of consistent views on priorities due to silos have also been noted by the participants as a significant challenge of resilience. More importantly, silos were seen to impact the organisational coherence as it may generate duplicative work and prevent awareness of interdependencies. Utilities should build on the ‘collaborative integration’ attribute in chapter 4 to foment a more inclusive organisation where the main underlying assumptions on the priorities for OR is consistent across different silos. If

coherence is not attained on the strategies and underpinning underlying assumptions for resilience, utilities may struggle to develop the emergent behaviour required to cope with unprecedented threats (Schein & Schein, 2017).

5.2.2 *Implication of opportunities:*

Even though the participants evidenced that utilities tend to favour more technical and tangible solutions, in chapter 3 and 4 there was also a strong recognition of building social capital internally and externally. Chapter 3 underscores a strong appetite for meaningful engagement and the importance of building strong social networks with customers to gain their active support throughout the resilience journey. In addition, it was recognised that effective engagement could foster individual resilience and its cumulative effect could support wider water services' coping capacity during disruptions. These insights, therefore, suggest that there is a strong willingness to strengthen internal and external social ties meaningfully to ensure lasting collaboration and creation of support networks of resilience. Creating and maintaining support networks will be crucial to ensure individuals are responsive to internal and external adaptiveness and flexibility needs.

Similarly in chapter 4 some of the attributes in the validated framework showcased the awareness of personnel as crucial assets that require investment, not necessarily financially, by setting up a positive, stimulating, and awarding work environment. In particular, the validated attribute 'well-being' evidenced an additional recognition of the importance of staff and suggested a willingness to further efforts beyond the minimum requirements of utilities' duty of care to personnel.

Building on the opportunities of leveraging social capital, the insights from chapter 3 denoted that customers' collaboration and agency for resilience have not yet been fully leveraged by utilities. There is an untapped potential to facilitate customers' support in resilience through meaningful and targeted engagement. The identified drive from participants to involve customers in the resilience agenda by sharing the complexities faced by utilities, is coupled with impressions that utilities cannot, by themselves, meet the long-term resilience needs of water services. This quest will entail commitment from utilities in engaging customers regularly, with an accessible language and an approach that is tailored to different socio-economic communities. Maximizing the support from customers will be paramount in attending to diversified and more complex shocks and stresses, as customers' collaboration can enhance utilities' coping capacity, assist in effective planning, provide early identification of threats, promote resilience advocacy, develop responsive behavioral-change and a drive to innovate.

The cultural framework validated by water sector professionals is an important initial step towards embedding OR. Utilities can utilise the framework to probe and establish what each attribute represent to the them in terms of artefacts and guiding values and beliefs. They can proceed to map out their current organisational culture by utilising the levels of culture modified in chapter 3 to explore their internal cognitive frame and any societal/cultural influence. This will assist in the assessment of any discrepancies between the broken-down structure of an organisational culture of OR and their existing culture. As such, applying the framework and the tools derived from chapter 3 will facilitate a more pragmatic familiarisation with their own culture and a better identification of current barriers in the way of an organisational culture of OR.

The need for a centralised organisational structure to sustain the commitment of resilience efforts flagged in chapter 2 - and which was not previously noted in literature - can serve as an internal commitment to support changes to values and beliefs of personnel and the incorporation of the attributes from the cultural framework proposed in chapter 4. A centralised structure may also compel leadership's sustained support and facilitate building the case to allocate resources to more intangible resilience efforts focused more strongly in the organisational and social domains. However, such approach must clearly elucidate how adapting the human capabilities in utilities may be beneficial to the short- and long-term resilience of water services. Language when pitching for investment in the human domains of resilience will still need to account the heavily technical world-views of personnel in utilities in order to gain support across the organisation.

5.3 Implications for policy

In order for water utilities to be equipped in building OR, the challenges identified in this thesis will have to be managed appropriately. This study highlights that organisational and social capabilities of resilience in water utilities still need to be further developed if their benefits were to be maximised in response to an increased complexity of disruptions. Therefore, policy-makers could support such quest by equally underscoring the importance of developing organisational and social capabilities alongside other metrics such as planning and financial resilience (Ofwat, 2017). For instance, organisational culture plays a crucial role in shaping personnel's behaviour which is extremely important when preventing and responding to disruptions and delivering a reliability sentence to physical assets. Therefore, a more overt support from policy-makers on developing these capabilities can augment utilities' impetus to implement positive changes. As such, this

thesis can also support the creation of policy guidelines on developing social and organisational capabilities of resilience in water utilities.

From an organisational perspective, utilities evinced key organisational challenges that impeded the development of resilience efforts. This indicates that policy-makers may need to re-visit current policy to account the realities of water utilities towards feasible progress on resilience. For instance, resource constraints coupled with strong focus on robustness leads to a reduced inclination by utilities in experimenting towards innovative solutions, thus preventing the further development of important solutions, such as SUDS. Such complexities need to be considered during policy-making to enable utilities to have a safe space to foment innovation whilst ensuring the reliability of water services.

The services provided by water utilities are for the benefit of society. However, providing resilient water services are influenced by factors that go beyond the boundaries of water utilities. This illustrates the complex interdependencies that utilities must manage to address resiliency requirements. Policies should comprehensively cross-over different regional scales and thematic areas to prevent policy-making in isolation that neglect the complexities of critical services. Policy makers could approach this challenge in varying ways; through more cross-cutting policy with a wider reach, or parallel policy for differing areas to assure alignment with resilience targets.

Chapter 3 elucidated this complexity through the exploration of customers' role in building the resilience of water service. The perceptions captured were from water utilities representatives and currently little is known about the expectations from regulators and policy-makers on how customers and the public in general can support utilities in ensuring the resilience of water services. Therefore, policy-makers could better

define their views of a reasonable level and type of support that could be expected and incentivised from customers, so water utilities can more appropriately define roles, plan on how to more appropriately engage customers on resilience efforts.

5.4 Implications for the water sector:

The cultural framework devised from chapter 4 drew from different disciplines and different types of CIS. The validation of the framework suggests that some learnings from different disciplines, and in particular other types of CIS, are transferrable to the water sector. Likewise, other sectors may benefit from resilience lessons drawn from the water sector. Therefore, water utilities should leverage collaboration and cooperation amongst other CIS, especially around human domains of resilience, such as organisational dynamics, culture, and interactions with customers. This will strengthen the contextual element of OR, by expanding supportive resource networks before, during and after a crisis. Building such ties will also provide a better understanding and management of interdependencies (Rinaldi et al., 2001) and a more coordinated approach across different CIS when responding to complex disruptions.

Although internal and external interdependencies have been identified throughout this study (chapter 2, 3 and 4), grey literature guiding water utilities mention the importance of utilities to grasp a variety of interdependencies without further elaborating on different levels of interdependencies from a wider variety of sources (EUM, 2016; Ofwat, 2017; Smith et al., 2019). Being that internal interdependencies amongst operational personnel and senior leadership, technical professions from different expertise background or amongst water utilities and customers, utilities need start developing mechanisms that enable a more panoramic and comprehensive view of different levels and systems that

may affect their resilience. The interdependencies impacting physical assets as well as human assets through the social and organisational capabilities (internally and externally) should be accounted to map out risks and vulnerabilities more holistically.

Chapter 2 identified a narrow understanding of resilience that was focused on robustness, and risk management and confusion about resilience's definition from participants from non-English speaking countries. Similarly, perceptions on organisational culture in chapter 4 was closer aligned with artefacts (structures and processes), as opposed to organisational values, beliefs, and behaviour. This indicates a real need for water utilities to address these misconceptions, demystify resilience as jargon and expand personnel's understanding of key concepts that support the resilience of water services. For instance, internal awareness of different elements that encompass resilience can foment a more diverse and comprehensive creation of strategies and allocation of resources, may empower personnel to challenge decision-making more confidently and effectively, and feed into the transition towards and organisational culture of OR.

Strengthening social networks with different customer segments can serve as an important contextual factor to building OR. As underscored by the findings in chapter 3, meaningful and effective customer engagement is required to increase responsiveness and optimise customers' support in building the resilience of water services. The sentiment of the need to advance and refine efforts on customer engagement by the participants signal to water utilities that the current approach of interaction with customers has not been able to fully leverage the resilience opportunities for the water sector. As identified here by water utilities' representatives themselves, resilience is a capability that is not only built by water utilities but through the collaboration of wide spectrum of stakeholders - and

customers are important protagonists. There is, therefore, an untapped potential to steer customers as active agents of further developing the resilience of water services.

5.5 Reflections on context

The international water utilities observed in this study come from different backgrounds and contexts. The contextual findings were predominantly structured by the following groups:

- 1) public water utilities and private water utilities.
- 3) water utilities from higher income countries and lower income countries.
- 5) utilities experiencing regular disruptions and utilities not experiencing regular disruptions.

The contextual findings of public and private utilities were more visible in chapter 2 and were centred on financial limitations experienced by both types, though influenced by slightly different limitations with similar motives (to protect ratepayers). Public utilities were more acutely impacted by short-term strategies due to political cycles and lack of funding which was linked to protecting the electorate from bearing the brunt. Whereas private utilities were vocal about stringent water price determination by regulators to protect ratepayers, which hindered resilience investments. This reinforced the political context utilities are immersed in and the criticality of utilities in attaining socio-political will for short and long-term resilience though developing the contextual property of OR that entails building broad social networks through interactive interpersonal connections.

The participants' perceptions from water utilities of lower income countries were centred strongly on the inability of these utilities to invest in resilience due to scarce resources, and the need to address more impending priorities such as deficiencies on the quality of service (chapter 2). Similarly, in chapter 3, it was also noted that these utilities have a tendency to employ reactive modes of engagement with customers and are more susceptible to reputation damage. Contrarily, water utilities from high-income countries showcased a higher level of maturity in relation to resilience investments and capabilities.

For instance, it was noted in chapter 3 that utilities from higher-income countries cited a range of two-way engagement initiatives, and pro-active and innovative ways to interact with customers. This is also likely because, US, UK and Australia (the majority of the higher-income share in this study's sample) have strong regulatory drivers for meaningful engagement and resilience advancements as opposed to lower-income countries. This indicates that water utilities from lower-income countries may be in a disadvantageous position to advance broad social networks with stakeholders (customers and regulators) due to lack of resources to do so, as these two factors are key enablers of OR.

Regular exposure to disruptions appeared to facilitate resilience investments and greater proactive engagement with customers. Chapter 2 evinced the challenge of maintaining resilience investments to preserve resilience levels in a context without visible disruptions. Elsewhere, chapter 3 highlighted that participants from utilities that had experienced disruptions were more vocal about successful behaviour-change and interactive initiatives with customers. This highlights how the recency of disruptive events can significantly impact the political, social and organisational impetus to maintain resilience initiatives and investments, thus supporting the development of diffuse power and accountability for resilience.

The contextual elements in this study evince that all types of water utilities experience challenges in building OR. Specifically, challenges related to lack of funding and resources cut across all groupings and directly impact the propensity of utilities to invest in resilience and in pro-active customer engagement to target positive customers' roles. However, it is undeniable that utilities from lower income countries are more vulnerable to potential disruptions and do not have the means to develop contextual properties of OR – organisational resources and broad social networks. This vulnerability is compounded if such utilities do not experience regular shocks and stress, which could support the business-case for more resilience investments. This highlights the unequal context international utilities are exposed to when it comes to resilience, given that resources are significant determinants of resilience investments and OR. Context will always affect the drive for resilience and level of investments, though mechanisms should be in place to allow the development and maintenance of essential resilience capabilities regardless of differing levels of resources.

5.6 Methodology: final reflections and contributions

Based on the underpinning constructivist and interpretivism paradigms of this research, where humans shape and modify reality, this study adopted an inductive design with flexible methods that enabled new questions to arise and steer the research. Although semi-structured interviews and thematic analysis are established tools in qualitative research, this thesis recruited a unique international sample composed of high- and lower-income countries that are immersed in different realities who view the prospective of building resilience differently. The generalisability intent of the findings is to provide analytical refinement, as opposed to contradict or create new theories (Tsoukas, 2009). This study, therefore, delivers an analytical refinement as it enriches the body of knowledge on the challenges and opportunities to building OR in international water utilities (Buchanan & Denyer, 2013).

The analytical framework by Lengnick-Hall et al., (2011) applied in the analysis of chapter 2 chosen, due to its social and organisational elements, supported to clarify an incipient gap on the lack of research centred on the human dimensions of resilience. To the best of the researcher's knowledge, it is the first time in resilience research for the water sector that this analytical framework is applied to probe and clarify meaning of the organisational reality within utilities.

In chapter 4, for the first time in resilience research for the water sector, cultural attributes conducive of OR were identified by drawing from literature of different disciplines and related to the RAG framework (Hollnagel et al., 2011) to showcase their relevance to resilience. Furthermore, chapter 4 employed a Delphi approach to validate an organisational culture of OR framework. The modified Delphi supported the suitability

assessment of the proposed framework, whilst generating in-depth qualitative data and ensuring an interactive involvement of the participants.

In response to challenges derived from COVID-19, the successful application of the Delphi reinforced its suitability in research settings where live social interactions are not possible. The analytical criteria for the qualitative findings in chapter 4 was drawn from Holsapple & Joshi, (2000), but also refined through the novel and introductory examination of any contradiction between quantitative and qualitative responses. In addition, the secondary, stage which involved the organisation of qualitative responses, also further developed the analytical criteria, and optimised the researcher's efforts through carefully sifting the data for the subsequent analysis.

The three-levelled model of organisational culture by Schein & Schein, (2017) is also extended through the novel splitting of artefacts: (1) artefacts as observed behaviour; and (2) artefacts as structures and processes. This adopted modification and additional layer augmented the clarity of the analysis and could be drawn from future studies aiming to examine organisational culture more pragmatically.

The shift from technocratic approaches to better understanding the human dimensions in resilience research for the water sector is also consistent with the methodological choices in this study. The predominant utilisation of qualitative methods in this research and the subjective nature of constructivism generated findings that are non-generalisable. However, this study produced meaningful insights based on the perceptions of key individuals that hold leadership roles and experience first-hand the realities of water utilities and are involved in the tactical and strategic decision-making process. This

enabled a more in-depth understanding of the current organisational and social setting in utilities in relation to OR.

The utilisation of the semi-structured interviews and the Delphi approach supported meaningful, pragmatic, and interactive research process. Notably, the application of the Delphi attested that substantial qualitative data can still be produced remotely with indirect interaction in response to socialisation constraints. The analytical frameworks applied across different chapters created an additional dimension to the meaning of the findings and supported a more targeted and theoretically sound analysis in relation to the research questions and their relevance to resilience. The theoretical refinements throughout, allowed the application of analytical frameworks that were suited to the methods applied and the context of the research.

Finally, caution was advised to scholars when applying the Delphi method given the contrasting views identified on organisational culture even though a definition was clearly shared to the survey participants from the outset (see Appendix C). Scholars should take note that even if a concept is defined as the premise for the survey responses, respondents may disregard the proposed definition due to their strong views of a particular concept. This was exemplified through the findings of the survey in chapter 3 where organisational culture was articulated as standards and procedures by participants, regardless of the initial definition which stated that organisational culture is composed of behaviour, values and beliefs.

5.7 Future research

Given that this thesis was based on perceptions from managers and senior-managers within utilities, future research should also account the views of frontline personnel on resilience and how does that relate to the organisational, dynamics, culture, and interactions with customers. This will support a more thorough assessment on how views from operational staff relate with the findings provided here by leaders. This is crucial because leadership may be unaware of the challenges to resilience taking place and opportunities that can be capitalised as part of the operational reality.

The perception of customers should also be captured to better understand what could be expected as a reasonable support from different customers segments for the resilience of water services. This will enable the identification of a common ground on what could be instituted (informally or formally) as the role of customers in building resilience. Likewise, their views on what should be expected from water utilities in developing resilience should also be factored in to grasp their understanding of the realities and limitations of water utilities and level of current engagement.

Similarly, the views of higher up senior-leaders such as shareholders, board members and governmental decision-makers should also be reflected in future studies in response to the gap above on the uncertainty of leadership commitment in building water resilience. It would be key to gain knowledge on their perceptions of the and complexities experienced by utilities, their awareness of trade-offs involved in resilience and their motivations (or lack of) to explicitly support resilience efforts.

Ethnographic work should also take place to obtain a more accurate understanding of the organisational culture in different water utilities and their propensity in embedding an organisational culture of OR, specially through case-studies comparing high – and lower-income utilities. This endeavour will enable a more detailed visualisation of differences and similarities in the organisational dynamics, culture and interactions with customer and provide opportunities for learning from each other on best-practices. As such, resilience efforts could be better tailored to the different realities, instead of being prescribed by generalised frameworks, that although signpost different elements of resilience, they often fail to account the specific regional and socio-economic challenges.

Given that our sample was predominantly composed of higher-income countries, the results were naturally more influenced by the insights from the majority, given the higher breadth of responses from high-income countries. Although some findings identified some issues that were felt more acutely by lower-income countries (e.g.: resource constraints, low quality of services, and reactive engagement with customers), additional exploration is needed on the particularities of their reality in relation to resilience. Future research should inspect in more detail their current environment to grasp a more accurate view of their challenges and opportunities to building resilience. Gaining such knowledge can support the development of additional resilience guidance and resources that is more tailored to their needs to complement existing prescribed resilience frameworks and tools.

Fully embedding reactivity as a resilience capability equally to pro-activeness needs to be further explored in future research. Throughout this study it was observed that pro-activeness may not always be practical to water utilities, thus understanding how to refine a reactive behaviour that would lead to a resilient outcome needs to be further investigated

in literature. As observed in chapter 2, some utilities highlighted lack of resources to pre-emptively allocate resilience initiatives when they have needs that require immediate investments and attention. In addition, the attribute ‘adaptiveness’ was further refined by the participants in chapter 3 to reflect that adaptiveness entails proactive as well as reactive behaviours. Further, chapter 4 also noted a reactive relationship with customers that made sense from a cost-effective point of view, given the utility had pressures to keep tariffs as low as possible and did not have enough resources to build resilience proactively. Therefore, additional work should be focused on exploring key principles that make a reactive behaviour conducive to resilience and how can reactivity and proactivity complement each other. Such an inquiry may enhance the accessibility of resilience efforts across utilities with different constraints.

The application of the organisational culture of OR framework should also be examined through future research. The process of embedding the cultural attributes as organisational values and beliefs should be documented to identify insights regarding organisational self-reflection and the process of challenging existing underlying assumptions to make room for new values and beliefs conducive to resilience. As organisational culture is in the heart of OR, forthcoming OR studies for critical systems should use the framework as a tool to be tailored to specific contexts. The framework would benefit from an additional structure where each attribute is broken down as the layered model organisational culture adapted here and devised by Schein & Schein, (2017). This will provide a better illustration of what individual attributes may look like as underlying assumptions, values and beliefs, and artefacts as structures and processes and as observed behaviour.

References:

- Adams, E. (2010). The joys and challenges of semi-structured interviewing. *Community Practitioner: The Journal of the Community Practitioners' & Health Visitors' Association*, 83(7), 18–21. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/20701187>
- Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347–364. <https://doi.org/10.1191/030913200701540465>
- Ahern, J. (2011). From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world. *Landscape and Urban Planning*, 100(4), 341–343. <https://doi.org/10.1016/j.landurbplan.2011.02.021>
- Akamani, K. (2016). Adaptive Water Governance: Integrating the Human Dimensions into Water Resource Governance. *Journal of Contemporary Water Research & Education*, 158(1), 2–18. <https://doi.org/10.1111/j.1936-704X.2016.03215.x>
- Akamani, K., Wilson, P. I., & Hall, T. E. (2015). Barriers to collaborative forest management and implications for building the resilience of forest-dependent communities in the Ashanti region of Ghana. *Journal of Environmental Management*, 151, 11–21. <https://doi.org/10.1016/j.jenvman.2014.12.006>
- Akhmouch, A., & Clavreul, D. (2016). Stakeholder Engagement for Inclusive Water Governance: “Practicing What We Preach” with the OECD Water Governance Initiative. *Water*, 8(5), 204. <https://doi.org/10.3390/w8050204>
- Alexander, D. E. (2013). Resilience and disaster risk reduction: An etymological journey. *Natural Hazards and Earth System Sciences*, 13(11), 2707–2716.

<https://doi.org/10.5194/nhess-13-2707-2013>

Alvesson, M. (2002). *Understanding Organizational Culture*. Wiltshire: SAGE Publications.

Amir, S., & Kant, V. (2018). Sociotechnical Resilience: A Preliminary Concept. *Risk Analysis*, 38(1), 8–16. <https://doi.org/10.1111/risa.12816>

Ananda, J., Pawsey, N., & Nayeem, T. (2022). Customer-centric regulation: The case of Victorian urban water sector. *Regulation & Governance*, 16(2), 536–556. <https://doi.org/10.1111/regg.12368>

Anderies, J. M., Folke, C., Walker, B., & Ostrom, E. (2013). Aligning key concepts for global change policy: Robustness, resilience, and sustainability. *Ecology and Society*, 18(2). <https://doi.org/10.5751/ES-05178-180208>

Arbin, K., Frostenson, M., Helin, S., & Borglund, T. (2021). Explaining workers' resistance against a health and safety programme: An understanding based on hierarchical and social accountability. *Safety Science*, 136(November 2020), 105131. <https://doi.org/10.1016/j.ssci.2020.105131>

Arnett, D. B., Laverie, D. A., & McLane, C. (2002). Using job satisfaction and pride as internal-marketing tools. *The Cornell Hotel and Restaurant Administration Quarterly*, 43(2), 87–96. [https://doi.org/10.1016/S0010-8804\(02\)80035-0](https://doi.org/10.1016/S0010-8804(02)80035-0)

Arnstein, S. R. (1969). A Ladder Of Citizen Participation. *Journal of the American Planning Association*, 35(4), 216–224. <https://doi.org/10.1080/01944366908977225>

Australian Government. (2016). *Organisational Resilience Good business guide*. Retrieved from <https://www.organisationalresilience.gov.au/Documents/Organisational-Resilience-Good-Business-Guide.PDF>

- Avella, J. (2016). Delphi Panels: Research Design, Procedures, Advantages, and Challenges. *International Journal of Doctoral Studies*, 11, 305–321. <https://doi.org/10.28945/3561>
- Badia, E., Navajas, J., & Losilla, J.-M. (2020). Safety Culture in the Spanish Nuclear Power Plants through the Prism of High Reliability Organization, Resilience and Conflicting Objectives Theories. *Applied Sciences*, 11(1), 345. <https://doi.org/10.3390/app11010345>
- Baehler, K. J., & Biddle, J. C. (2018). Governance for adaptive capacity and resilience in the U.S. water sector. *Ecology and Society*, 23(4). <https://doi.org/10.5751/ES-10537-230424>
- Baker, K., Tang, S., Sweetapple, C., Ward, S., Staddon, C., Bulmer, P., & Butler, D. (2018). Resilience Learning for Water Sector Culture Change. In E. W. Association (Ed.), *6th Joint EWA/JSWA/WEF Conference "The Resilience of the Water Sector"* (pp. 6–26). Munich. Retrieved from <https://ore.exeter.ac.uk/repository/handle/10871/40063>
- Balaei, B., Wilkinson, S., & Potangaroa, R. (2019a). Social capacities in fostering water supply resilience in Vanuatu. *Disaster Prevention and Management: An International Journal*, 28(5), 706–720. <https://doi.org/10.1108/DPM-08-2018-0278>
- Balaei, B., Wilkinson, S., Potangaroa, R., Adamson, C., & Alavi-Shoshtari, M. (2019b). Social factors affecting water supply resilience to disasters. *International Journal of Disaster Risk Reduction*, 37(September 2018), 101187. <https://doi.org/10.1016/j.ijdrr.2019.101187>
- Biddle, J. C., & Baehler, K. J. (2019). Autonomy matters: Insights from U.S. water utility managers on governance structure. *AWWA Water Science*, 1(3), e1140. <https://doi.org/10.1002/aws2.1140>
- Biggs, S. E., Banks, T. D., Davey, J. D., & Freeman, J. E. (2013). Safety leaders' perceptions

- of safety culture in a large Australasian construction organisation. *Safety Science*, 52, 3–12. <https://doi.org/10.1016/j.ssci.2012.04.012>
- Bisbey, T. M., Kilcullen, M. P., Thomas, E. J., Ottosen, M. J., Tsao, K., & Salas, E. (2021). Safety Culture: An Integration of Existing Models and a Framework for Understanding Its Development. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 63(1), 88–110. <https://doi.org/10.1177/0018720819868878>
- Brady, S. R. (2016). The Delphi Method. In *Foresight in Organizations* (Vol. 35, pp. 79–99). Routledge. <https://doi.org/10.4324/9781315728513-10>
- Brand, F. S., & Jax, K. (2007). Focusing the Meaning(s) of Resilience: Resilience as a Descriptive Concept and a Boundary Object. *Ecology and Society*, 12(1), art23. <https://doi.org/10.5751/ES-02029-120123>
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Research in Psychology*, (1), 2071–2079. <https://doi.org/10.1016/j.bbapap.2013.06.007>
- Braun, Virginia, & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. <https://doi.org/10.1191/1478088706qp063oa>
- Brown, C., Seville, E., & Vargo, J. (2017). Measuring the organizational resilience of critical infrastructure providers: A New Zealand case study. *International Journal of Critical Infrastructure Protection*, 18, 37–49. <https://doi.org/10.1016/j.ijcip.2017.05.002>
- Bruneau, M., Chang, S. E., Eguchi, R. T., Lee, G. C., O'Rourke, T. D., Reinhorn, A. M., ... Von Winterfeldt, D. (2003). A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities. *Earthquake Spectra*, 19(4), 733–752. <https://doi.org/10.1193/1.1623497>

- Bryman, A. (2012). *Social Research Methods* (4th ed.). New York: Oxford University Press Inc.
- Buchanan, D. A. (2012). Case Studies in Organizational Research. In *Qualitative Organizational Research: Core Methods and Current Challenges* (pp. 351–370). 1 Oliver's Yard, 55 City Road London EC1Y 1SP: SAGE Publications, Inc. <https://doi.org/10.4135/9781526435620.n20>
- Burnard, K., & Bhamra, R. (2011). Organisational resilience: development of a conceptual framework for organisational responses. *International Journal of Production Research*, 49(18), 5581–5599. <https://doi.org/10.1080/00207543.2011.563827>
- Cabinet Office. (2011). *Keeping the Country Running: Natural Hazards and Infrastructure*. London. Retrieved from <http://www.cabinetoffice.gov.uk/resource-library/keeping-country-running-natural-hazards-and-infrastructure>
- Carpenter, Stephen, Arrow, K., Barrett, S., Biggs, R., Brock, W., Crépin, A.-S., ... Zeeuw, A. (2012). General Resilience to Cope with Extreme Events. *Sustainability*, 4(12), 3248–3259. <https://doi.org/10.3390/su4123248>
- Carpenter, Steve, Walker, B., Anderies, J. M., & Abel, N. (2001). From Metaphor to Measurement: Resilience of What to What? *Ecosystems*, 4(8), 765–781. <https://doi.org/10.1007/s10021-001-0045-9>
- Carter, K., & Hawkins, A. (2019). Joy at work. *Nursing Management*, 50(12), 34–42. <https://doi.org/10.1097/01.NUMA.0000605156.88187.77>
- Chalker, R. T. C., Pollard, S. J. T., Leinster, P., & Jude, S. (2018). Appraising longitudinal trends in the strategic risks cited by risk managers in the international water utility sector,

- 2005–2015. *Science of The Total Environment*, 618, 1486–1496.
<https://doi.org/10.1016/j.scitotenv.2017.09.294>
- Chester, M. V., & Allenby, B. (2019). Toward adaptive infrastructure: flexibility and agility in a non-stationarity age. *Sustainable and Resilient Infrastructure*, 4(4), 173–191.
<https://doi.org/10.1080/23789689.2017.1416846>
- Coutu, D. L. (2002). How resilience works. *Harvard Business Review*, (1709). Retrieved from
<https://hbr.org/2002/05/how-resilience-works>
- Crick, R., & Bentley, J. (2020). Becoming a resilient organisation: integrating people and practice in infrastructure services. *International Journal of Sustainable Engineering*, 13(6), 423–440. <https://doi.org/10.1080/19397038.2020.1750738>
- Cypress, B. S. (2017). Rigor or Reliability and Validity in Qualitative Research. *Dimensions of Critical Care Nursing*, 36(4), 253–263.
<https://doi.org/10.1097/DCC.0000000000000253>
- Dahmen, P. (2023). Organizational resilience as a key property of enterprise risk management in response to novel and severe crisis events. *Risk Management and Insurance Review*, 203–245. <https://doi.org/10.1111/rmir.12245>
- Davoudi, S., Shaw, K., Haider, L. J., Quinlan, A. E., Peterson, G. D., Wilkinson, C., ...
 Davoudi, S. (2012). Resilience: A Bridging Concept or a Dead End? “Reframing” Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does it Mean in Planni. *Planning Theory & Practice*, 13(2), 299–333.
<https://doi.org/10.1080/14649357.2012.677124>

- Decker, C. (2018). Utility and regulatory decision-making under conditions of uncertainty: Balancing resilience and affordability. *Utilities Policy*, 51, 51–60. <https://doi.org/10.1016/j.jup.2018.01.007>
- Dekker, S. W. A., & Breakey, H. (2016). “Just culture:” Improving safety by achieving substantive, procedural and restorative justice. *Safety Science*, 85, 187–193. <https://doi.org/10.1016/j.ssci.2016.01.018>
- Denison, D. R., & Mishra, A. K. (1995). Toward a Theory of Organizational Culture and Effectiveness. *Organization Science*, 6(2), 204–223. <https://doi.org/10.1287/orsc.6.2.204>
- Denyer, D. (2017). *Organizational resilience: A summary of academic evidence, business insights and new thinking*. Retrieved from [https://www.bsigroup.com/Documents/our-services/Organizational-resilience/Documents/Organizational-Resilience-Cranfield-Research- Report.pdf](https://www.bsigroup.com/Documents/our-services/Organizational-resilience/Documents/Organizational-Resilience-Cranfield-Research-Report.pdf)
- Desjardins, E., Barker, G., Lindo, Z., Dieleman, C., & Dussault, A. C. (2015). Promoting Resilience. *The Quarterly Review of Biology*, 90(2), 147–165. <https://doi.org/10.1086/681439>
- Doorn, N., Gardoni, P., & Murphy, C. (2019). A multidisciplinary definition and evaluation of resilience: the role of social justice in defining resilience. *Sustainable and Resilient Infrastructure*, 4(3), 112–123. <https://doi.org/10.1080/23789689.2018.1428162>
- Duchek, S. (2020). Organizational resilience: a capability-based conceptualization. *Business Research*, 13(1), 215–246. <https://doi.org/10.1007/s40685-019-0085-7>
- Dunk, M. J., Owen, A., McMath, S. M., & Arikans, J. (2012). Remediation of polluted surface water outfalls - customer communication and changes in behaviour. *Water and Environment*

Journal, 26(2), 191–199. <https://doi.org/10.1111/j.1747-6593.2011.00275.x>

Dziedzic, R. M., & Karney, B. W. (2016). Analyzing water customer service expectations: A case study of the City of Guelph. *Utilities Policy*, 41, 67–76. <https://doi.org/10.1016/j.jup.2016.06.002>

Engle, N. L., & Lemos, M. C. (2010). Unpacking governance: Building adaptive capacity to climate change of river basins in Brazil. *Global Environmental Change*, 20(1), 4–13. <https://doi.org/10.1016/j.gloenvcha.2009.07.001>

Erol, O., Henry, D., Sauser, B., & Mansouri, M. (2010). Perspectives on measuring enterprise resilience. In *2010 IEEE International Systems Conference* (pp. 587–592). IEEE. <https://doi.org/10.1109/SYSTEMS.2010.5482333>

EUM. (2016). *Taking the Next Step: Findings of the Effective Utility Management Review Steering Group*. Retrieved from https://www.epa.gov/sites/production/files/2016-03/documents/eum_review_final_report_508.pdf

EUM (Effective Utility Management). (2017). *Effective Utility Management: A Primer for Water and WasteWater Utilities*. Retrieved from https://www.epa.gov/sites/production/files/2017-01/documents/eum_primer_final_508-january2017.pdf

Farrelly, M., & Brown, R. (2011). Rethinking urban water management: Experimentation as a way forward? *Global Environmental Change*, 21(2), 721–732. <https://doi.org/10.1016/j.gloenvcha.2011.01.007>

Fitzgerald, L., & Dopson, S. (2009). Comparative case study designs: their utility and development in organizational research. In D. A. Buchanan & A. Bryman (Eds.),

- Organizational Research Methods (p. 738). London: SAGE Publications.
- Folke, C. (2016). Resilience (Republished). *Ecology and Society*, 21(4), art44.
<https://doi.org/10.5751/ES-09088-210444>
- Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience Thinking: Integrating Resilience, Adaptability and Transformability. *Ecology and Society*, 15(4), 2018. Retrieved from
<http://www.ecologyandsociety.org/vol15/iss4/art20>
- Georgiadou, A., Mouzakis, S., & Askounis, D. (2022). Detecting Insider Threat via a Cyber-Security Culture Framework. *Journal of Computer Information Systems*, 62(4), 706–716.
<https://doi.org/10.1080/08874417.2021.1903367>
- Georgiadou, A., Mouzakis, S., Bounas, K., & Askounis, D. (2022). A Cyber-Security Culture Framework for Assessing Organization Readiness. *Journal of Computer Information Systems*, 62(3), 452–462. <https://doi.org/10.1080/08874417.2020.1845583>
- Gibson, C. A., & Tarrant, M. (2010). A ‘ conceptual models ’ approach to organisational resilience. *The Australian Journal of Emergency Management*, 8–14. Retrieved from
<https://knowledge.aidr.org.au/media/2909/ajem-25-02-03.pdf>
- Giffoni, E., Jude, S., Smith, H. M., & Pollard, S. J. T. (2022). Real-life resilience: Exploring the organisational environment of international water utilities. *Utilities Policy*, 79(August), 101394. <https://doi.org/10.1016/j.jup.2022.101394>
- Gittell, J. H., Cameron, K., Lim, S., & Rivas, V. (2006). Relationships, Layoffs, and Organizational Resilience. *The Journal of Applied Behavioral Science*, 42(3), 300–329.
<https://doi.org/10.1177/0021886306286466>

- Golladay, S. W., Craig, L. S., DePalma-Dow, A. D., Emanuel, B. N., & Rogers, S. G. (2020). Building resilience into water management through public engagement. *Freshwater Science*, 40(February 2020), 000–000. <https://doi.org/10.1086/712514>
- Gonçalves, L., & Patrício, L. (2022). From smart technologies to value cocreation and customer engagement with smart energy services. *Energy Policy*, 170(September), 113249. <https://doi.org/10.1016/j.enpol.2022.113249>
- Gover, L., & Duxbury, L. (2018). Inside the Onion: Understanding What Enhances and Inhibits Organizational Resilience. *The Journal of Applied Behavioral Science*, 54(4), 477–501. <https://doi.org/10.1177/0021886318797597>
- Graamans, E., ten Have, W., & ten Have, S. (2021). Against the current: Cultural psychology and culture change management. *Culture & Psychology*, 27(2), 325–343. <https://doi.org/10.1177/1354067X21993789>
- Guimarães, E. F., Malheiros, T. F., & Marques, R. C. (2016). Inclusive governance: New concept of water supply and sanitation services in social vulnerability areas. *Utilities Policy*, 43, 124–129. <https://doi.org/10.1016/j.jup.2016.06.003>
- Hahn, R., Metcalfe, R., & Rundhammer, F. (2020). Promoting customer engagement: A new trend in utility regulation. *Regulation & Governance*, 14(1), 121–149. <https://doi.org/10.1111/rego.12182>
- Hallowell, M. R., & Gambatese, J. A. (2010). Qualitative Research: Application of the Delphi Method to CEM Research. *Journal of Construction Engineering and Management*, 136(1), 99–107. [https://doi.org/10.1061/\(asce\)co.1943-7862.0000137](https://doi.org/10.1061/(asce)co.1943-7862.0000137)
- Hamel, G., & Valikangas, L. (2003). The quest for resilience. *Harvard Business Review*, 81(9),

<http://proquest.umi.com/pqdweb?did=395498971&Fmt=7&clientId=4574&RQT=309&VName=PQD%5Cnpapers3://publication/uuid/5041D63D-7A0F-47F7-B447-EF0EE63A7D9D>

- Harrison, T. R., Yang, F., Anderson, D., Morgan, S. E., Wendorf Muhamad, J., Talavera, E., ... Kobetz, E. (2017). Resilience, culture change, and cancer risk reduction in a fire rescue organization: Clean gear as the new badge of honor. *Journal of Contingencies and Crisis Management*, 25(3), 171–181. <https://doi.org/10.1111/1468-5973.12182>
- Hartmann, S., Weiss, M., Hoegl, M., & Carmeli, A. (2021). How does an emotional culture of joy cultivate team resilience? A sociocognitive perspective. *Journal of Organizational Behavior*, 42(3), 313–331. <https://doi.org/10.1002/job.2496>
- Harvey, E. J., Waterson, P., & Dainty, A. R. J. (2019). Applying HRO and resilience engineering to construction: Barriers and opportunities. *Safety Science*, 117, 523–533. <https://doi.org/10.1016/j.ssci.2016.08.019>
- Heims, E., & Lodge, M. (2017). Customer engagement in UK water regulation: towards a collaborative regulatory state? *Policy & Politics*, 46(1), 81–100. <https://doi.org/10.1332/030557317X15046029080815>
- Heino, O., & Anttiroiko, A.-V. (2016). Utility–Customer Communication. *Public Works Management & Policy*, 21(3), 220–230. <https://doi.org/10.1177/1087724X15606738>
- Helmrich, A. M., & Chester, M. V. (2020). Reconciling complexity and deep uncertainty in infrastructure design for climate adaptation. *Sustainable and Resilient Infrastructure*, 00(00), 1–17. <https://doi.org/10.1080/23789689.2019.1708179>

- Hendry, S. (2016). The customer forum – putting customers at the centre of regulating water services. *Water Policy*, 18(4), 948–963. <https://doi.org/10.2166/wp.2016.199>
- Hillmann, J., & Guenther, E. (2021). Organizational Resilience: A Valuable Construct for Management Research? *International Journal of Management Reviews*, 23(1), 7–44. <https://doi.org/10.1111/ijmr.12239>
- HM Government. Water Act (2014). UK. Retrieved from <http://www.legislation.gov.uk/ukpga/2014/21/contents/enacted>
- Hofstede, G. (2010). *Cultures and organizations: software of the mind: international cooperation and its importance for survival*. (Rev. and e). McGraw-Hill.
- Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, 4(1), 1–23. <https://doi.org/10.1146/annurev.es.04.110173.000245>
- Holling, C. S. (1996). Engineering Resilience versus Ecological Resilience. In *Engineering Within Ecological Constraints* (p. 224). Washington, DC: National Academy of Engineering. <https://doi.org/10.17226/4919>
- Holling, C. S., & Meffe, G. K. (1996). Command and Control and the Pathology of Natural Resource Management. *Conservation Biology*, 10(2), 328–337. <https://doi.org/10.1046/j.1523-1739.1996.10020328.x>
- Hollnagel, E. (2011). RAG - the Resilience Analysis Grid. In E. Hollnagel, J. Paries, D. Woods, & J. Wreathall (Eds.), *Resilience Engineering in Practice* (p. 321). Surrey: Ashgate.
- Hollnagel, E. (2014). Resilience engineering and the built environment. *Building Research & Information*, 42(2), 221–228. <https://doi.org/10.1080/09613218.2014.862607>

- Hollnagel, E., & Fujita, Y. (2013). The Fukushima Disaster - Systemic Failure as the Lack of Resilience. *Nuclear Engineering and Technology*, 45(1), 13–20. <https://doi.org/10.5516/NET.03.2011.078>
- Hollnagel, E., Paries, J., Woods, D., & Wreathall, J. (2011). *Resilience Engineering in Practice*. (Ashgate, Ed.). Farnham.
- Holsapple, C. W., & Joshi, K. D. (2000). An investigation of factors that influence the management of knowledge in organizations. *The Journal of Strategic Information Systems*, 9(2–3), 235–261. [https://doi.org/10.1016/S0963-8687\(00\)00046-9](https://doi.org/10.1016/S0963-8687(00)00046-9)
- Hopkins, A. (2006). Studying organisational cultures and their effects on safety. *Safety Science*, 44(10), 875–889. <https://doi.org/10.1016/j.ssci.2006.05.005>
- Hrudey, S. E., Hrudey, E. J., & Pollard, S. J. T. (2006). Risk management for assuring safe drinking water. *Environment International*, 32(8), 948–957. <https://doi.org/10.1016/j.envint.2006.06.004>
- Johannessen, Å., Rosemarin, A., Thomalla, F., Gerger Swartling, Å., Axel Stenström, T., & Vulturius, G. (2014). Strategies for building resilience to hazards in water, sanitation and hygiene (WASH) systems: The role of public private partnerships. *International Journal of Disaster Risk Reduction*, 10(PA), 102–115. <https://doi.org/10.1016/j.ijdrr.2014.07.002>
- Johnson, G. (1992). Managing strategic chance: strategy, culture and action. *Long Range Planning*, 25(1), 9–19. [https://doi.org/10.1016/0024-6301\(92\)90307-N](https://doi.org/10.1016/0024-6301(92)90307-N)
- Juan-García, P., Butler, D., Comas, J., Darch, G., Sweetapple, C., Thornton, A., & Corominas, L. (2017). Resilience theory incorporated into urban wastewater systems management. State of the art. *Water Research*, 115, 149–161.

<https://doi.org/10.1016/j.watres.2017.02.047>

Koronis, E., & Ponis, S. (2018). Better than before: the resilient organization in crisis mode.

Journal of Business Strategy, 39(1), 32–42. <https://doi.org/10.1108/JBS-10-2016-0124>

Lawson, E., Farmani, R., Woodley, E., & Butler, D. (2020). A Resilient and Sustainable Water

Sector: Barriers to the Operationalisation of Resilience. *Sustainability*, 12(5), 1797.

<https://doi.org/10.3390/su12051797>

Lee, A. V., Vargo, J., & Seville, E. (2013). Developing a Tool to Measure and Compare

Organizations' Resilience. *Natural Hazards Review*, 14(1), 29–41.

[https://doi.org/10.1061/\(ASCE\)NH.1527-6996.0000075](https://doi.org/10.1061/(ASCE)NH.1527-6996.0000075)

Lengnick-Hall, C. A., & Beck, T. E. (2005). Adaptive Fit Versus Robust Transformation: How

Organizations Respond to Environmental Change. *Journal of Management*, 31(5), 738–

757. <https://doi.org/10.1177/0149206305279367>

Lengnick-Hall, C. A., Beck, T. E., & Lengnick-Hall, M. L. (2011). Developing a capacity for

organizational resilience through strategic human resource management. *Human*

Resource Management Review, 21(3), 243–255.

<https://doi.org/10.1016/j.hrmr.2010.07.001>

Leong, C., & Li, L. (2017). Singapore and Sydney: Regulation and Market-Making. *Water*,

9(6), 434. <https://doi.org/10.3390/w9060434>

Lindsay, J., Rogers, B. C., Church, E., Gunn, A., Hammer, K., Dean, A. J., & Fielding, K.

(2019). The Role of Community Champions in Long-Term Sustainable Urban Water

Planning. *Water*, 11(3), 476. <https://doi.org/10.3390/w11030476>

Linkov, I., & Palma-Oliveira, J. M. (2017). An Introduction to Resilience for Critical

- Infrastructures. In *Resilience and Risk* (pp. 3–17). Dordrecht. <https://doi.org/10.1007/978-94-024-1123-2>
- Littlechild, S. (2014). The Customer Forum: Customer engagement in the Scottish water sector. *Utilities Policy*, 31, 206–218. <https://doi.org/10.1016/j.jup.2014.10.002>
- Macrae, C. (2019). Moments of resilience: Time, Space and the Organisation of Safety in Complex Sociotechnical System. In *Exploring Resilience: A Scientific Journey from Practice to Theory* (pp. 15–23). Stavanger. <https://doi.org/https://doi.org/10.1007/978-3-030-03189-3>
- Mafabi, S., Munene, J. C., & Ahiauzu, A. (2015). Creative climate and organisational resilience: the mediating role of innovation. *International Journal of Organizational Analysis*, 23(4), 564–587. <https://doi.org/10.1108/IJOA-07-2012-0596>
- Mahmoud, N. N., & Rothenberger, D. (2019). From Burnout to Well-Being: A Focus on Resilience. *Clinics in Colon and Rectal Surgery*, 32(6), 415–423. <https://doi.org/10.1055/s-0039-1692710>
- Malinen, S., Hatton, T., Naswall, K., & Kuntz, J. (2019). Strategies to enhance employee well-being and organisational performance in a postcrisis environment: A case study. *Journal of Contingencies and Crisis Management*, 27(1), 79–86. <https://doi.org/10.1111/1468-5973.12227>
- Marshall, B. K., & Jones, R. E. (2005). CITIZEN PARTICIPATION IN NATURAL RESOURCE MANAGEMENT: DOES REPRESENTATIVENESS MATTER? *Sociological Spectrum*, 25(6), 715–737. <https://doi.org/10.1080/02732170500256732>
- Mas-Machuca, M., Berbegal-Mirabent, J., & Alegre, I. (2016). Work-life balance and its

- relationship with organizational pride and job satisfaction. *Journal of Managerial Psychology*, 31(2), 586–602. <https://doi.org/10.1108/JMP-09-2014-0272>
- Mauelshagen, C., Denyer, D., Carter, M., & Pollard, S. (2013). Respect for experience and organisational ability to operate in complex and safety critical environments. *Journal of Risk Research*, 16(9), 1187–1207. <https://doi.org/10.1080/13669877.2012.761273>
- McAslan, A. (2010). *Resilience origins and utility. Understanding its Origins, Meaning and Utility*. Retrieved from <https://www.flinders.edu.au/content/dam/documents/research/torrens-resilience-institute/resilience-origins-and-utility.pdf>
- Moser, S., Meerow, S., Arnott, J., & Jack-Scott, E. (2019). The turbulent world of resilience: interpretations and themes for transdisciplinary dialogue. *Climatic Change*, 153(1–2), 21–40. <https://doi.org/10.1007/s10584-018-2358-0>
- Naderpajouh, N., Yu, D. J., Aldrich, D. P., Linkov, I., & Matinheikki, J. (2018). Engineering meets institutions: an interdisciplinary approach to the management of resilience. *Environment Systems and Decisions*, 38(3), 306–317. <https://doi.org/10.1007/s10669-018-9704-7>
- Noble, H., & Smith, J. (2015). Issues of validity and reliability in qualitative research. *Evidence Based Nursing*, 18(2), 34–35. <https://doi.org/10.1136/eb-2015-102054>
- Ofwat. (2016). *Ofwat's customer engagement policy statement and expectations for PR19*. Retrieved from https://www.ofwat.gov.uk/wp-content/uploads/2015/12/pap_pos20160525w2020cust.pdf
- Ofwat. (2017). *Resilience in the round: Building resilience for the future*. Retrieved from

<https://www.ofwat.gov.uk/publication/resilience-in-the-round/>

- Omar, Y. Y., Parker, A., Smith, J. A., & Pollard, S. J. T. (2017). Risk management for drinking water safety in low and middle income countries - cultural influences on water safety plan (WSP) implementation in urban water utilities. *Science of the Total Environment*, 576, 895–906. <https://doi.org/10.1016/j.scitotenv.2016.10.131>
- Pahl-Wostl, C. (2009). A conceptual framework for analysing adaptive capacity and multi-level learning processes in resource governance regimes. *Global Environmental Change*, 19(3), 354–365. <https://doi.org/10.1016/j.gloenvcha.2009.06.001>
- Pahl-Wostl, C., Craps, M., Dewulf, A., Mostert, E., Tabara, D., & Taillieu, T. (2007). Social Learning and Water Resources Management. *Ecology and Society*, 12(2), art5. <https://doi.org/10.5751/ES-02037-120205>
- Pawsey, N., Nayeem, T., & Huang, X. (2018). Use of facebook to engage water customers: A comprehensive study of current U.K. and Australian practices and trends. *Journal of Environmental Management*, 228(February), 517–528. <https://doi.org/10.1016/j.jenvman.2018.08.063>
- Petersen, L., Fallou, L., Reilly, P., & Serafinelli, E. (2020). Public expectations of critical infrastructure operators in times of crisis. *Sustainable and Resilient Infrastructure*, 5(1–2), 62–77. <https://doi.org/10.1080/23789689.2018.1469358>
- Petersen, L., Lundin, E., Fallou, L., Sjöström, J., Lange, D., Teixeira, R., & Bonavita, A. (2020). Resilience for whom? The general public's tolerance levels as CI resilience criteria. *International Journal of Critical Infrastructure Protection*, 28, 100340. <https://doi.org/10.1016/j.ijcip.2020.100340>

- Pollard, S., Gormley, Á., Shaw, H., Mauelshagen, C., Hrudey, S., Owen, D., ... Pritchard, R. (2013). *Risk Governace: An Implementation Guide for Water Utilities*. Denver. Retrieved from <https://www.waterrf.org/research/projects/risk-governance-implementation-guide-water-utilities>
- Pollard, S. J. T., Bradshaw, R., Tranfield, D., Charrois, J.W.A., Cromar, N., Jalba, D., Hrudey, S. E., ... Lloyd, R. (2009). *Developing a Risk Management Culture—'Mindfulness' in the International Water Utility Sector*. Denver: Water Research Foundation. Retrieved from <https://www.waterrf.org/resource/developing-risk-management-culture-mindfulness-international-water-utility-sector-0>
- Pollard, S. J. T., Strutt, J. E., MacGillivray, B. H., Sharp, J. V., Hrudey, S. E., & Hamilton, P. D. (2006). Risk management capabilities – towards mindfulness for the international water utility sector. In *Water contamination emergencies: enhancing our response* (pp. 70–80). Cambridge: Royal Society of Chemistry Publishing. Retrieved from <https://pubs.rsc.org/en/content/ebook/978-0-85404-658-4>
- Pollard, S., Mauelshagen, C., Owen, D., Fesko, P., & Reekie, L. (2014). From risk assessment to risk governance: real world experiences on the road to improved utility resilience. In *AWWA/WEF Utility Management Conference 2014: Making Progress More Apparent* (Vol. 2014, pp. 1–10). <https://doi.org/10.2175/193864714816100786>
- Pomeranz, E. F., Decker, D. J., Siemer, W. F., Kirsch, A., Hurst, J., & Farquhar, J. (2014). Challenges for Multilevel Stakeholder Engagement in Public Trust Resource Governance. *Human Dimensions of Wildlife*, 19(5), 448–457. <https://doi.org/10.1080/10871209.2014.936069>
- Poulter, H., & Bolton, R. (2023). Embedding broader values in the regulatory model: An

- analysis of Ofgem's consumer value proposition for the natural gas distribution sector. *Utilities Policy*, 80(October 2018), 101470. <https://doi.org/10.1016/j.jup.2022.101470>
- Powley, E. H. (2013). The Process and Mechanisms of Organizational Healing. *The Journal of Applied Behavioral Science*, 49(1), 42–68. <https://doi.org/10.1177/0021886312471192>
- QSR International Pty Ltd. (2020). NVIVO Qualitative Data Analysis Software 12. QSR International. Retrieved from <https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home>
- Rahi, K. (2019). Indicators to assess organizational resilience – a review of empirical literature. *International Journal of Disaster Resilience in the Built Environment*, 10(2/3), 85–98. <https://doi.org/10.1108/IJDRBE-11-2018-0046>
- Reed, M. S., Vella, S., Challies, E., de Vente, J., Frewer, L., Hohenwallner-Ries, D., ... van Delden, H. (2018). A theory of participation: what makes stakeholder and public engagement in environmental management work? *Restoration Ecology*, 26(April), S7–S17. <https://doi.org/10.1111/rec.12541>
- Reinmoeller, P., & Van Baardwijk, N. (2005). The link between diversity and resilience. *MIT Sloan Management Review*, 46(4), 61–65. <https://sloanreview.mit.edu/article/the-link-between-diversity-and-resilience/>
- Resilient Organisations (ResOrgs). (2012). What is organisational resilience? Retrieved June 29, 2020, from <https://www.resorgs.org.nz/about-resorgs/what-is-organisational-resilience/>.
- Rinaldi, S. M., Peerenboom, J. P., & Kelly, T. K. (2001). Identifying, Understanding, and Analyzing, Critical Infrastructure interdependencies, 11–25. Retrieved from

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.89.2276&rep=rep1&type=pdf>

Rodina, L. (2019a). Defining “water resilience”: Debates, concepts, approaches, and gaps.

Wiley Interdisciplinary Reviews: Water, 6(2), e1334. <https://doi.org/10.1002/wat2.1334>

Rodina, L. (2019b). Planning for water resilience: Competing agendas among Cape Town’s planners and water managers. *Environmental Science & Policy*, 99(May), 10–16.

<https://doi.org/10.1016/j.envsci.2019.05.016>

Rodina, L., Baker, L. A., Galvin, M., Goldin, J., Harris, L. M., Manungufala, T., ... Ziervogel, G. (2017). Water, equity and resilience in Southern Africa: future directions for research and practice. *Current Opinion in Environmental Sustainability*, 26–27, 143–151.

<https://doi.org/10.1016/j.cosust.2017.09.001>

Rodríguez, M., Lawson, E., & Butler, D. (2020). A study of the Resilience Analysis Grid method and its applicability to the water sector in England and Wales. *Water and Environment Journal*, 34(4), 623–633. <https://doi.org/10.1111/wej.12539>

Sawalha, Ihab Hanna S., Anchor, J. R., & Meaton, J. (2015). Continuity Culture: A Key Factor for Building Resilience and Sound Recovery Capabilities. *International Journal of Disaster Risk Science*, 6(4), 428–437. <https://doi.org/10.1007/s13753-015-0070-5>

Sawalha, Ihab Hanna Salman. (2015). Managing adversity: understanding some dimensions of organizational resilience. *Management Research Review*, 38(4), 346–366. <https://doi.org/10.1108/MRR-01-2014-0010>

Sayles, R., Smith, H. M., & Jeffrey, P. (2021). Customer priorities for water and wastewater services: a comparative evaluation of three elicitation methods. *Water and Environment Journal*, 35(1), 55–66. <https://doi.org/10.1111/wej.12575>

- Schein, E. H., & Schein, P. A. (2017). *Organizational Culture and Leadership* (5th ed.). Hoboken: John Wiley & Sons. Retrieved from <https://web.s.ebscohost.com/ehost/ebookviewer/ebook/bmxlYmtfXzE0MzMxMTdfX0F00?sid=54a729a4-d90e-4763-b791-f160984deb2b@redis&vid=0&format=EB&rid=1>
- Schulman, P. R. (2020). Organizational structure and safety culture: Conceptual and practical challenges. *Safety Science*, 126(October 2019), 104669. <https://doi.org/10.1016/j.ssci.2020.104669>
- Schwandt, T. A. (1994). Constructivist, interpretivist approaches to human inquiry. In *Handbook of qualitative research* (pp. 118–137). SAGE Publications. Retrieved from <http://psycnet.apa.org/psycinfo/1994-98625-006>
- Sellberg, M. M., Ryan, P., Borgström, S. T., Norström, A. V., & Peterson, G. D. (2018). From resilience thinking to Resilience Planning: Lessons from practice. *Journal of Environmental Management*, 217, 906–918. <https://doi.org/10.1016/j.jenvman.2018.04.012>
- Sheffi, Y., & Rice, J. B. (2005). A Supply Chain View of the Resilient Enterprise. *MIT Sloan Management Review*, 47(1), 41–49. Retrieved from <https://sloanreview.mit.edu/article/a-supply-chain-view-of-the-resilient-enterprise/>
- Smith, A. F., & Plunkett, E. (2019). People, systems and safety: resilience and excellence in healthcare practice. *Anaesthesia*, 74(4), 508–517. <https://doi.org/10.1111/anae.14519>
- Smith, H., Jude, S., & Williams, L. (2019). *Resilient Water Infrastructure: Improving Understanding and Assessing Needs*. Retrieved from <https://www.waterrf.org/research/projects/resilient-water-infrastructure-improving-understanding-and-assessing-needs>

- Snel, K. A. W., Witte, P. A., Hartmann, T., & Geertman, S. C. M. (2020). The shifting position of homeowners in flood resilience: From recipients to key-stakeholders. *WIREs Water*, 7(4), 1–11. <https://doi.org/10.1002/wat2.1451>
- Summerill, C., Pollard, S. J. T., Smith, J. A., Breach, B., & Williams, T. (2011). Securing executive buy-in for preventative risk management – lessons from water safety plans. *Water Supply*, 11(6), 682–691. <https://doi.org/10.2166/ws.2011.074>
- Summerill, Corinna, Pollard, S. J. T., & Smith, J. A. (2010). The role of organizational culture and leadership in water safety plan implementation for improved risk management. *Science of the Total Environment*, 408(20), 4319–4327. <https://doi.org/10.1016/j.scitotenv.2010.06.043>
- Sweya, L. N., Wilkinson, S., Kassenga, G., & Mayunga, J. (2020). Developing a tool to measure the organizational resilience of Tanzania's water supply systems. *Global Business and Organizational Excellence*, 39(2), 6–19. <https://doi.org/10.1002/joe.21985>
- Tang, Y., Wu, S., Miao, X., Pollard, S. J. T., & Hrudehy, S. E. (2013). Resilience to evolving drinking water contamination risks: a human error prevention perspective. *Journal of Cleaner Production*, 57, 228–237. <https://doi.org/10.1016/j.jclepro.2013.06.018>
- Tangenæs, T., & Steen, R. (2017). The trinity of resilient organisation: aligning performance management with organisational culture and strategy formation. *International Journal of Business Continuity and Risk Management*, 7(2), 127. <https://doi.org/10.1504/IJBCRM.2017.10007179>
- Taylor, R., May, J., Weyman, A., & Carhart, N. (2017). Understanding organisational and cultural precursors to events. *Proceedings of the Institution of Civil Engineers - Forensic Engineering*, 170(3), 124–133. <https://doi.org/10.1680/jfoen.17.00006>

- Tepes, A., & Neumann, M. B. (2020). Multiple perspectives of resilience: A holistic approach to resilience assessment using cognitive maps in practitioner engagement. *Water Research*, 178, 115780. <https://doi.org/10.1016/j.watres.2020.115780>
- Thaler, T., & Levin-Keitel, M. (2016). Multi-level stakeholder engagement in flood risk management-A question of roles and power: Lessons from England. *Environmental Science and Policy*, 55, 292–301. <https://doi.org/10.1016/j.envsci.2015.04.007>
- Timmerman, P. (1981). Vulnerability, resilience and the collapse of society: a review of models and possible climatic applications. Environmental Monograph. <https://doi.org/https://doi.org/10.1002/joc.3370010412>
- Timmerman, J. G., & Langaas, S. (2005). Water information: what is it good for? The use of information in transboundary water management. *Regional Environmental Change*, 5(4), 177–187. <https://doi.org/10.1007/s10113-004-0087-6>
- Tracey, S., O’Sullivan, T. L., Lane, D. E., Guy, E., & Courtemanche, J. (2017). Promoting Resilience Using an Asset-Based Approach to Business Continuity Planning. *SAGE Open*, 7(2), 215824401770671. <https://doi.org/10.1177/2158244017706712>
- Tsoukas, H. (2009). Craving for generality in small-n studies: A Wittgensteinian approach towards the epistemology of the particular in organisation and management studies. In D. A. Buchanan & A. Bryman (Eds.), *Organizational Research Methods* (p. 738). London: SAGE Publications
- UKWIR. (2017). Resilience: Performance measures, costs and stakeholder communication. Retrieved from https://www.ukwir.org/eng/forefront-report-page?al=true&al_id=233705&al_ticket=Jw2041l2jLj69FJ&al_uid=85687&object=180174&Email_Campaign_Mail=439964

- United States Environmental Protection Agency (EPA). (2017). Water Infrastructure Financial Leadership: Successful Financial Tools for Local Decision Makers. Retrieved from https://www.epa.gov/sites/production/files/2017-09/documents/financial_leadership_practices_document_final_draft_9-25-17_0.pdf
- US Government. America's Water Infrastructure Act (2018). Congress. Retrieved from <https://www.congress.gov/115/bills/s3021/BILLS-115s3021enr.pdf>
- van der Merwe, S. E., Biggs, R., & Preiser, R. (2018). A framework for conceptualizing and assessing the resilience of essential services produced by socio-technical systems. *Ecology and Society*, 23(2), art12. <https://doi.org/10.5751/ES-09623-230212>
- van der Vegt, G. S., Essens, P., Wahlström, M., & George, G. (2015). Managing Risk and Resilience. *Academy of Management Journal*, 58(4), 971–980. <https://doi.org/10.5465/amj.2015.4004>
- Wallis-Lage, C. (2015). Drive for Resilience Requires Greater Engagement. *Journal - American Water Works Association*, 107(11), 77–83. <https://doi.org/10.5942/jawwa.2015.107.0170>
- Weick, K. E., & Sutcliffe, K. M. (2015). Managing the unexpected: sustained performance in a complex world (Third edit). Jossey-Bass. Retrieved from <https://www.vlebooks.com/Product/Index/619155?page=0>
- Zaato, J. J., & Ohemeng, F. L. K. (2015). Building Resilient Organizations for Effective Service Delivery in Developing Countries: The Experience of Ghana Water Company Limited. *Forum for Development Studies*, 42(3), 507–528.

<https://doi.org/10.1080/08039410.2015.1036112>

Zimmermann, K., Paries, J., Amalberti, R., & Hummerdal, D. H. (2014). Is the Aviation Industry Ready for Resilience? Mapping Human Factors Assumptions Across the Aviation Sector. In Resilience Engineering in Practice (Ashgate). Farnham.

APPENDICES

Appendix A - Interview Protocol and Consent Form

A.1 Interview Protocol

INTRODUCTION

The PhD student Eduarda Giffoni is currently engaged in the project ‘Real-life enterprise resilience in international water utilities’ funded by the Water Research Foundation in collaboration with Cranfield University. The project will explore resilience solutions and provide enterprise resilience guidance for the water sector.

Prior to agreeing to participate in this study, it is important to understand what it involves and why it is being done. Please read the following information carefully.

PURPOSE OF THE STUDY

The aim of the project is to support utilities to manage for enhanced resilience by informing current knowledge gaps in theory and practice, identifying available resilience resources and support resilience capacity-building.

The project is composed of the following outputs:

- Output 1: Scoping workshop with international water utilities.
- Output 2: A highly focused literature review.
- Output 3: Collation of resilience landmark resources.
- Output 4: Semi-structured interviews.
- Output 5: Assembly of a research-informed 'i-book'.
- Output 6: Final pilot testing and delivery.

DECIDING TO TAKE PART

It is up to you to decide whether to take part. If you would like participate, you will be asked to sign a consent form after reading this information sheet. Even after you decide to take part, you are still free to withdraw at any time without giving a specific reason.

If you agree, the interview session will be tape recorded to fully capture the flow of information from participant to researcher. The extent of your participation would be limited to an

interview, which should not be longer than 60 minutes and take place at the agreed location or by telephone/Skype at a time convenient to you.

CONFIDENTIALITY AND ETHICS

All the information given will be kept strictly confidential and your name will be substituted with an anonymous participant code in any records that is kept. The only person that will have access to records of the sessions and tapes is the researcher and these will be stored securely for a maximum period of 7 (seven) years then destroyed. At the end of the project, the written report produced will protect the name and privacy of participants.

This research is supervised by Simon Jude s.jude@cranfield.ac.uk and Heather Smith h.m.smith@cranfield.ac.uk in partnership with the Water Research Foundation. If you have any concerns about the conduct of this study, you may contact researchdata@cranfield.ac.uk.

INTERVIEW STRUCTURE

Interview questions will be semi-structured, relying on a list of pre-defined questions. Semi-structure questions will establish a focus for the interviewer, but still allow a free flow of ideas and information around specific themes. The interviewer will adopt a probing technique to solicit insights specific to the themes. This approach provides more focus than the conversational approach, typically adopted in qualitative interviews, but still allows a degree of freedom and adaptability for participants to retain autonomy in shaping the discussion.

Interview questions will focus on examining how resilience efforts are currently being held in the water sector. It will also aim to discover the resilience drivers, challenges, and opportunities from the perspective of water utility managers. The interview findings will provide information upon which recommendations can be drawn for the remainder of the research.

- Interview questions provided below are based on the following key themes:
- Enterprise resilience.
- Social and organisational aspects of resilience.
- Resilience opportunities and challenges.
- Resilience within assets and organisation.
- Stakeholders and resilience.
- Resilience tools.

A.2 Informed consent form

Title of the project:	Real-life enterprise resilience in international water utilities.
Name of the researcher:	Eduarda Giffoni
Researcher's contact details:	<i>e.giffoni@cranfield.ac.uk</i>
Participant number:	
Date:	

1. I confirm that I have been informed about this research project and I agree to take part.

2. I understand that all personal information I provide will be treated with confidence and my name will not be used in any report, publication, or presentation.

3. I have been provided with a participant number as shown above. The researcher(s) will record data against my participant number instead of recording my name. The file linking my name to my participant number will be accessible only to the main researchers, and will be securely destroyed after 7 years.

4. I understand that I can withdraw from this project at any stage by informing a member of the research team, for whom contact details have been provided. I also understand that I can withdraw my data for a period of up to two weeks from today, as after this time it will not be possible to identify my individual data from the aggregated results as explained in point 3.

5. I understand that the data I provide will be used by Cranfield University for the purpose of research. The data will be stored on the University's network that can only be accessed by authorised users, in line with UK Data Protection Act 2018.

6. Interviews will be recorded and securely stored on the Cranfield University network as audio files. These audio files will be securely deleted as soon as they are no longer required.

7. The recordings will be transcribed and saved as text files. These files (and any backups) will also be securely deleted as soon as they are no longer required.

8. Anonymised transcripts will be created, by removing or replacing identifiers such as name, age, and location. These anonymised transcripts may be quoted from or published in full, in support of findings (e.g., in journal articles, conference papers).

☐ I am happy for my anonymised transcript to be published:

9. Analytical software will be used to aggregate the results of the research and every reasonable step will be taken to anonymise the data.

☐ I understand that the aggregated data will be published in support of the research findings.

☐ I understand that the discussions will be audio recorded and transcribed for analysis. The analysis will be only used for this research project and no other purpose.

I confirm that I have read and understand the information provided on this form and give my consent to taking part in this research.

Participant's signature:		Date:	
Participant's name:			
Researcher's signature:		Date:	

Appendix B - Interview Topic Guide

September 2019

Organisation:	Interview code:	Date:
1. Introduction		
Welcome to the interview session and thank you for deciding to take part in this activity as part of the project ‘Real-life enterprise resilience in international water utilities. This research project is funded by Water Research Foundation in collaboration with international water utilities and Cranfield University. This research aims to support utilities to advance efforts of resilience comprehensively.		

Participation on this activity is completely voluntary and you are free to withdrawn at any time. If you agree, the interview session will be tape recorded to fully capture the flow of information from participant to researcher. The extent of your participation would be limited to an interview, which should not be longer than 60 minutes.

This research will comply with the rules specified by the UK Data Protection Act. All the information given will be kept strictly confidential and your name will be substituted with an anonymous participant code in any records that is kept. The only person that will have access to records of the sessions and tapes is the researcher and these will be stored securely for a maximum period of 7 years, then destroyed. If you have any concerns about the conduct of this study, you may contact researchdata@cranfield.ac.uk

The PhD student Eduarda Giffoni e.giffoni@cranfield.ac.uk is currently engaged in the project and is supervised by Simon Jude s.jude@cranfield.ac.uk and Heather Smith h.m.smith@cranfield.ac.uk at Cranfield University.

- Do you have any questions about the research project?
- Do you have any questions about this activity?
- Would you like to participate?

2. The interviewee

Job role:

What is your current role?

What is the scope of your work?

Which department of the business is you role allocated to?

Responsibilities:

What are your main responsibilities?

How are your responsibilities delivered?

3. Enterprise Resilience

Primary question	Secondary questions/ prompts	Notes
What is your understanding of enterprise resilience?	• How does enterprise resilience benefit utilities? • How should enterprise resilience work in practice? • What hinders enterprise resilience within utilities? • In your opinion, what are the changes required to achieve enterprise-wide resilience? • Do you think enterprise resilience is different to other forms of resilience?	

	• What should be the boundary of enterprise resilience?	
4. Social and organisational aspects of enterprise resilience		
Primary question	Secondary questions/ prompts	Notes
What are the social and organisational aspects that underpin enterprise resilience?	• Why do social and organisational changes support enterprise resilience? • What are the opportunities of adapting social and organisational capabilities for resilience? • What do these changes look like? • How should these changes be incorporated? • What are the barriers to adapting social and organisational capabilities to support enterprise resilience?	
5. Resilience within assets and organisation		

Primary question	Secondary questions/ prompts	Notes
How does the relationship between physical infrastructure and the organisation can be adapted to foster enterprise resilience?	• What are the necessary changes required between these two domains to progress a utility's enterprise resilience?	
6. Stakeholders		
Primary question	Secondary questions/ prompts	Notes
How should be the engagement with and involvement of government when seeking enterprise resilience?	• What are the challenges? • What are the opportunities? • What is like in reality?	
How should be the engagement with and involvement of the supply-chain when	• What are the challenges? • What are the opportunities?	

seeking enterprise resilience?	• What is like in reality?	
How should be the engagement with and involvement of civil society when seeking enterprise resilience?	• What are the challenges? • What are the opportunities? • What is like in reality?	
How should be the engagement with and involvement of shareholders and customers when seeking enterprise resilience?	• What are the challenges? • What are the opportunities? • What is like in reality?	
What initiatives should be implemented in the wider natural environment by utilities	• How should they be shaped? • What are the challenges? • What are the opportunities?	

to foster enterprise resilience?	• What is like in reality?	
How should be the engagement with and involvement of other critical systems when seeking enterprise resilience?	• What are the challenges? • What are the opportunities? • What is like in reality?	
7. Tools		
Primary question	Secondary questions/ prompts	Notes
What resilience tools/resources are currently being used that account organisational efforts towards enterprise resilience?	• How was your experience with it? • What were the benefits? • What were the challenges? • How do you assess progress? • Are you aware of any other tools/resources?	

8. Wrap up.

Would you like to add anything else?

Is there any other topic you would like to further explore in the context of enterprise resilience?

Do you have any questions?

Appendix C – Survey analytical process

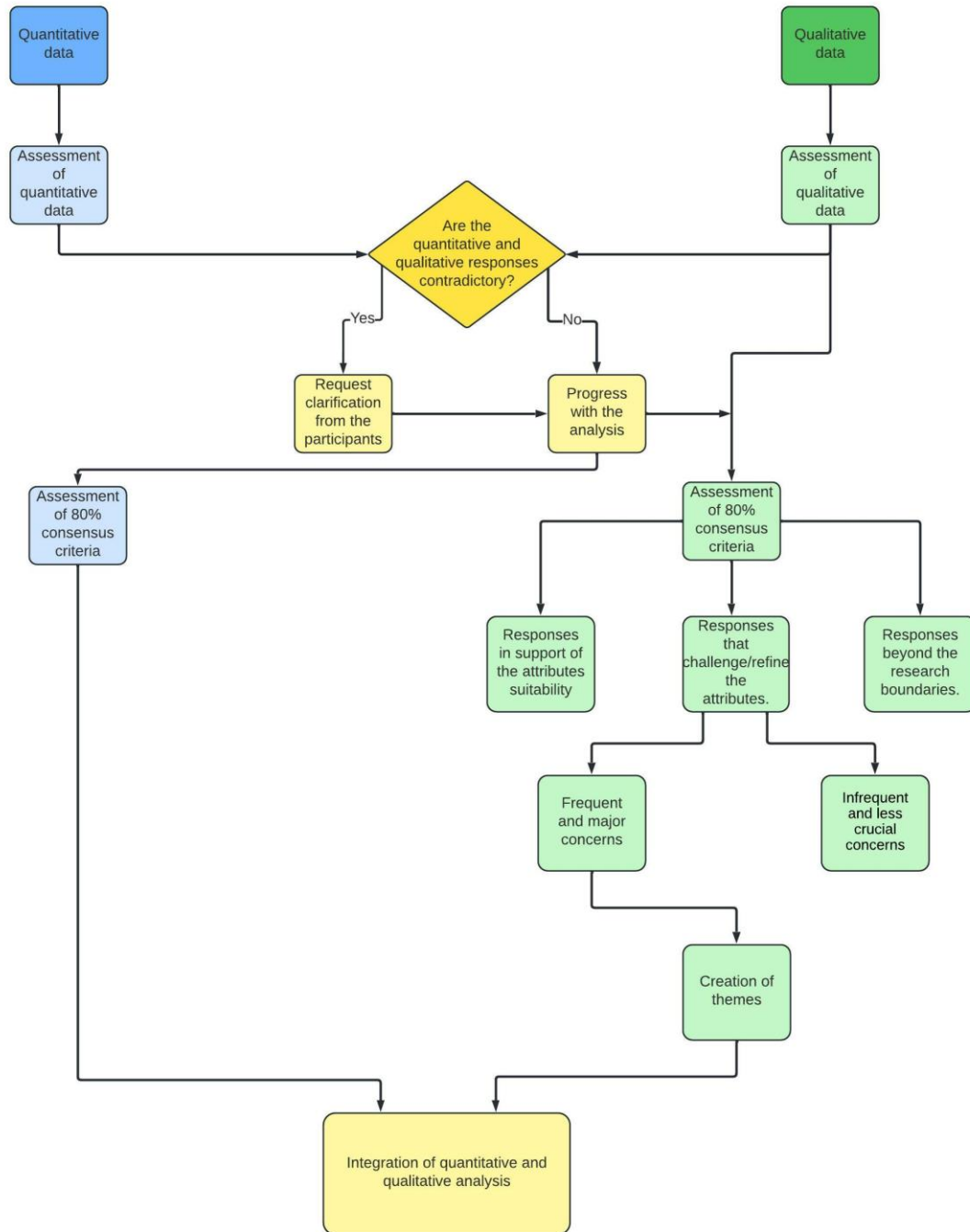


Figure C-1: Analytical process of quantitative and qualitative data of cultural attributes adapted from Holsapple & Joshi, (2000).

Appendix D - Organisational Resilience Culture Framework (Round 1)

Start of Block: Informed Consent

Q1 Consent Form

This survey contributes to the research project “Real-life Enterprise Resilience in International Water Utilities” at Cranfield University in partnership with the Water Research Foundation.

This survey aims to validate a set of cultural attributes that contribute to the Organisational Resilience of water utilities. The validation work will support the creation of an Organisational Resilience Culture Framework for the water sector.

We would like to capture your views on the proposed cultural attributes by responding to this questionnaire. Your participation in the validation of the framework will help to inform future research and practice on the role of culture in building the organisational resilience of water utilities.

Your participation in this questionnaire is voluntary and you can stop at any point without your responses being included in the dataset. All data collected in this survey will be held securely and the results will be confidential with responses reported anonymously at the group level in final reports. This study also abides by the ethical requirements from Cranfield University.

If you have any queries or comments about this survey, or would like to know more about the research project, please contact Eduarda Giffoni (e.giffoni@cranfield.ac.uk). This survey will take approximately 15 minutes to complete We greatly value your input and contribution

into this important work. By proceeding, you give your consent to participate in this study. Do you consent to take part in this study?

☐ Yes (1)

☐ No (2)

Skip To: End of Block If Consent Form This survey contributes to the research project

“Real-life Enterprise Resilien... = Yes

Skip To: End of Survey If Consent Form This survey contributes to the research project

“Real-life Enterprise Resilien... = No

End of Block: Informed Consent

Start of Block: Demographics

Q2 Please state your full name below:

End of Block: Demographics

Start of Block: Cultural attributes

Q3 Context:

For the purpose of this study, the cultural attributes identified were devised based on the following conceptualisation of Organisational Resilience:

	Focus	Outcome
Organisational Resilience	To build cognitive, behavioural, and contextual properties that increase an organization's ability to understand its current situation and to develop customized responses to threats (Lengnick-Hall & Beck, 2005, p13).	The ability to effectively develop situation-specific responses, and implement activities to absorb and capitalize on disruptive surprises that threaten organization survival (Lengnick-Hall et al., 2011, p,2).

Culture was identified as a key component to the organisational resilience of the water sector.

We posit that culture stems from the organisation through the **daily habits and behaviour of individuals as well as explicit and unconscious beliefs and values.**

In view of the information above, we have identified **eight cultural attributes.**

Each of the eight attributes are presented on a **separate page** in this survey. On each page you will be asked whether the proposed attribute contributes to the **Organisational Resilience** of water utilities. You will also be asked to justify your answer and to propose any adjustments to the attributes' definition if you see it as necessary.

At the end of each page there is also space for you to leave any additional comments you

may have.

We thank you very much for your time.

End of Block: Cultural attributes

Start of Block: ADPTVE

Q4

Attribute 1:

Adaptiveness:

The organisation is equipped with a collective ability to repurpose existing systems and

behaviour as needed through proactive behaviour and a constant improvement of established ways of doing things.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know. (3)

Q5

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q6

Do you have any other comments about this attribute?

End of Block: ADPTVE

Start of Block: INCLS

Q7

Attribute 2:

Inclusiveness:

Individuals across the organisation have equal access to contribute in the decision-making of new policies and opportunities for growth, as explicit engagement is made with different personnel levels and areas prior, during and after decision-making.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q8

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q9

Do you have any other comments about this attribute?

End of Block: INCLS

Start of Block: INVTON

Q10

Attribute 3:

Inventiveness:

Creativity and experimentation are encouraged and applied by individuals in the organisation, as innovative changes are collectively welcomed when appropriate and perceived as a capability to better adapt to events.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q11

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q12

Do you have any other comments about this attribute?

End of Block: INVTON

Start of Block: INTGRTON

Q13

Attribute 4:

Collaborative Integration

Information is shared between teams and departments and different viewpoints and practice are encouraged to be shared and integrated.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q14

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q15

Do you have any other comments about this attribute?

End of Block: INTGRTON

Start of Block: JOY

Q16

Attribute 5:

Joyfulness

Cheerful behaviour and playful spirit in the organisation is valued and appreciated, as a positive work environment and high staff morale is collectively encouraged.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q17

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q18

Do you have any other comments about this attribute?

End of Block: JOY

Start of Block: PRDE

Q19

Attribute 6:

Sense of Pride

There is an understanding of the importance of individual contribution to the organisational objectives, individuals experience a feeling of satisfaction from personal and organisational achievements.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q20

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q21

Do you have any other comments about this attribute?

End of Block: PRDE

Start of Block: TST

Q22

Attribute 7:

Trust

Honesty is rewarded and incentivised so individuals can speak openly about problems and mistakes as there is a collective confidence of a supportive environment when raising concerns and reporting errors.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
 - ☐ No (2)
 - ☐ I don't know (3)
-

Q23

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q24

Do you have any comments about this attribute?

End of Block: TST

Start of Block: WLLBENG

Q25

Attribute 8:

Well-being

Regular discussions across the organisation take place to identify the professional and personal needs of staff members, as employees are supported to look after their physical, mental and spiritual health.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q26

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q27

Do you have any other comments about this attribute?

End of Block: WLLBENG

of Block: Block 12ultural Attributes	Description
Adaptiveness	<i>The organisation is equipped with a collective ability to repurpose existing systems and behaviour as needed through proactive behaviour and a constant improvement of established ways of doing things.</i>
Collaborative Integration	<i>Information is shared between teams and departments and different viewpoints and practice are encouraged to be shared and integrated.</i>
Inclusiveness	<i>Individuals across the organisation have equal access to contribute in the decision-making of new policies and opportunities for growth, as explicit engagement is made with different personnel levels and areas prior, during and after decision-making.</i>
Inventiveness	<i>Creativity and experimentation are encouraged and applied by individuals in the organisation, as innovative changes are collectively welcomed when appropriate and perceived as a capability to better adapt to events.</i>
Joyfulness	<i>Cheerful behaviour and playful spirit in the organisation is valued and appreciated, as a positive work environment and high staff morale is collectively encouraged.</i>
Sense of Pride	<i>There is a collective understanding of the importance of individual contribution to the organisational objectives, individuals experience a feeling of satisfaction from personal and organisational achievements.</i>

Trust	<i>Honesty is rewarded and incentivised so individuals can speak openly about problems and mistakes as there is a collective confidence of a supportive environment when raising concerns and reporting errors.</i>
Well-being	Regular discussions across the organisation take place to identify the professional and personal needs of staff members, as employees are supported to look after their physical, mental, and spiritual health.

Is there anything else or any other cultural attribute that should have been mentioned or changed?

Q29

If yes, please briefly elaborate.

End of Block: Block 12

Start of Block: Block 13

Q30 Thank you very much for taking the time to complete this survey, we value the information you have provided!

End of Block: Block 13

Appendix E - Organisational Resilience Culture Framework (Round 2)

Start of Block: Informed Consent

Q1 Consent Form

This activity contributes to the research project “Real-life Enterprise Resilience in International Water Utilities” by Cranfield University in partnership with the Water Research Foundation.

Building on the analysis of the responses from the 1st survey round we have made changes to the Cultural Framework. Based on these changes, we would like to capture your views on the amended framework by responding to this questionnaire.

Your participation in this **2nd round** will allow a more comprehensive understanding of cultural characteristics that contribute to resilience with the aim to validate a cultural framework tailored for the water sector.

Your participation in this questionnaire is voluntary and you can stop at any point without your responses being included in the dataset. All data collected in this survey will be held securely

and the results will be confidential with responses reported anonymously at the group level in final reports. This study also abides by the ethical requirements from Cranfield University.

If you have any queries or comments about this survey, or would like to know more about the research project, please contact Eduarda Giffoni (e.giffoni@cranfield.ac.uk). This survey will take approximately 20 minutes to complete.

We greatly value your input and contribution into this important work. By proceeding, you give your consent to participate in this study. Do you consent to take part in this study?

☐ Yes (1)

☐ No (2)

Skip To: End of Block If Consent Form This activity contributes to the research project

“Real-life Enterprise Resilien... = Yes

Skip To: End of Survey If Consent Form This activity contributes to the research project

“Real-life Enterprise Resilien... = No

End of Block: Informed Consent

Start of Block: Demographics

Q2 Please state your full name below:

End of Block: Demographics

Start of Block: Cultural attributes

Q3

Context:

For the purpose of this study, the cultural attributes identified were devised based on the following conceptualisation of Organisational Resilience:

	Focus	Outcome
Organisational Resilience	To build cognitive, behavioural, and contextual properties that increase an organization's ability to understand its current situation and to develop customized responses to threats (Lengnick-Hall & Beck, 2005, p13).	The ability to effectively develop situation-specific responses, and implement activities to absorb and capitalize on disruptive surprises that threaten organization survival (Lengnick-Hall et al., 2011, p,2).

Culture was identified as a key component to the organisational resilience of the water sector.

We posit that culture stems from the organisation through the **daily habits and behaviour of individuals as well as explicit and unconscious beliefs and values**. When responding to this survey please account the above definition of culture.

In view of the information above and your feedback from round 1, we have identified and refined **six cultural attributes**.

The attributes are presented on a **separate page** in this survey. On each page you will be asked whether the proposed attribute contributes to the **Organisational Resilience** of water utilities. You will also be asked to justify your answer and to propose any adjustments to the attributes' definition if you see it as necessary.

Finally, you will be able asked about the most and least important attributes, and why.

At the end of each page there is also space for you to leave any additional comments you may have.

We thank you very much for you time.

End of Block: Cultural attributes

Start of Block: ADPTVE

Q4 Attribute 1:

Adaptiveness:

The organisation is equipped with a collective mentality and ability to learn, and to repurpose

systems and behaviour as needed, reactively and proactively, to meet challenges and support improvement.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know. (3)

Q5

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q6

Do you have any other comments about this attribute?

End of Block: ADPTVE

Start of Block: INTGRTON

Q7

Attribute 2:

Collaborative Integration

There is a collective drive to share information effectively within the organisation and with external stakeholders, and to integrate diverse and challenging viewpoints before, during and after decision-making.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q08

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q09

Do you have any other comments about this attribute?

End of Block: INTGRTON

Start of Block: INVTON

Q10

Attribute 3:

Inventiveness:

Creativity and experimentation are actively encouraged across the organisation. Appropriate innovative solutions are collectively welcomed and perceived as a capability to better adapt to events.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q11

Could you please justify your answer? Please elaborate on how the above attribute may or

may not contribute to the Organisational Resilience of water utilities.

Q12

Do you have any other comments about this attribute?

End of Block: INVTON

Start of Block: PRDE

Q13

Attribute 4:

Sense of Pride

Individuals across the organisation are confident in their expertise and understand their contribution to the wider organisational objectives. Staff experience a feeling of satisfaction from individual and organisational achievements which are appreciated and celebrated.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
 - ☐ No (2)
 - ☐ I don't know (3)
-

Q14

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q15

Do you have any other comments about this attribute?

End of Block: PRDE

Start of Block: TST

Q16

Attribute 5:

Trust

Individuals of all levels feel empowered to speak openly about problems and propose solutions, and feel confident that concerns will be respected and acted upon. Errors are seen as valuable learning opportunities.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q17

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q18

Do you have any comments about this attribute?

End of Block: TST

Start of Block: WLLBENG

Q19

Attribute 6:

Well-being:

Professional and personal needs of all staff members are seen as important, and a positive work environment and good staff morale are encouraged. Employees are supported to look after their physical, mental, and spiritual health.

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

- ☐ Yes (1)
- ☐ No (2)
- ☐ I don't know (3)

Q20

Could you please justify your answer? Please elaborate on how the above attribute may or may not contribute to the Organisational Resilience of water utilities.

Q21

Do you have any other comments about this attribute?

End of Block: WLLBENG

Start of Block: Block 12

Cultural Attributes	Description
Adaptiveness	<i>The organisation is equipped with a collective ability to repurpose existing systems and behaviour as needed through proactive behaviour and a constant improvement of established ways of doing things.</i>
Collaborative Integration	<i>Information is shared between teams and departments and different viewpoints and practice are encouraged to be shared and integrated.</i>
Inventiveness	<i>Creativity and experimentation are encouraged and applied by individuals in the organisation, as innovative changes are collectively welcomed when appropriate and perceived as a capability to better adapt to events.</i>
Sense of Pride	<i>There is a collective understanding of the importance of individual contribution to the organisational objectives, individuals experience a feeling of satisfaction from personal and organisational achievements.</i>
Trust	<i>Honesty is rewarded and incentivised so individuals can speak openly about problems and mistakes as there is a collective confidence of a supportive environment when raising concerns and reporting errors.</i>
Well-being	<i>Regular discussions across the organisation take place to identify the professional and personal needs of staff members, as employees are supported to look after their physical, mental, and spiritual health.</i>

Which cultural attribute is the **most important** in building Organisational Resilience?

Q23

Please justify your answer.

Q24

Which cultural attribute is the **least important** in building Organisational Resilience?

Q25

Please justify your answer.

Q26 Is there anything else or any other cultural attribute that should have been mentioned or changed? If yes, please elaborate.

Appendix F - E-mail shared with the participants requesting their assessment of the analysis of the 1st survey round.

Dear Mr/Ms X,

I hope this finds you well.

I am sending this e-mail to share with you the group's responses of the 1st round of the cultural framework.

I am attaching here 10 separate documents - they are not big I promise!

The first document contains the overall quantitative results of the responses, documents 2 - 9 contain the qualitative responses of each attribute with some commentary from the researcher and, finally, document 10 contain your individual Yes/No responses.

May I kindly ask you to:

- A. read through the overall group's results and responses.
- B. assess whether you want to change your individual Yes/No responses in document 10?
- C. If you would like to make any changes to your Y/N responses, please forward your amended responses to me?

Could I respectfully ask you to get back to me by next Monday - 5th July 2021?

Please let me know if you have any questions.

Thank you very much for your time and support on this!

Eduarda Giffoni

Appendix G – Sample of quantitative results from the first survey round which was shared with participants.

Here we illustrate below the quantitative results (Figure G-1) from the cultural attributes survey where participants were asked whether each proposed attribute is conducive to resilience.

These results relate to the following information and questions on the survey:

Table G-0-1: Cultural attributes and description as shown in the survey.

Cultural Attributes	Description
Adaptiveness	<i>The organisation is equipped with a collective ability to repurpose existing systems and behaviour as needed through proactive behaviour and a constant improvement of established ways of doing things.</i>
Collaborative Integration	<i>Information is shared between teams and departments and different viewpoints and practice are encouraged to be shared and integrated.</i>
Inclusiveness	<i>Individuals across the organisation have equal access to contribute in the decision-making of new policies and opportunities for growth, as explicit engagement is made with different personnel levels and areas prior, during and after decision-making.</i>
Inventiveness	<i>Creativity and experimentation are encouraged and applied by individuals in the organisation, as innovative changes are collectively welcomed when appropriate and perceived as a capability to better adapt to events.</i>

Joyfulness	<i>Cheerful behaviour and playful spirit in the organisation are valued and appreciated, as a positive work environment and high staff morale is collectively encouraged.</i>
Sense of Pride	<i>There is a collective understanding of the importance of individual contribution to the organisational objectives, individuals experience a feeling of satisfaction from personal and organisational achievements.</i>
Trust	<i>Honesty is rewarded and incentivised so individuals can speak openly about problems and mistakes as there is a collective confidence of a supportive environment when raising concerns and reporting errors.</i>
Well-being	<i>Regular discussions across the organisation take place to identify the professional and personal needs of staff members, as employees are supported to look after their physical, mental, and spiritual health.</i>

Does this cultural attribute contribute to the Organisational Resilience of water utilities?

Yes No I don't know

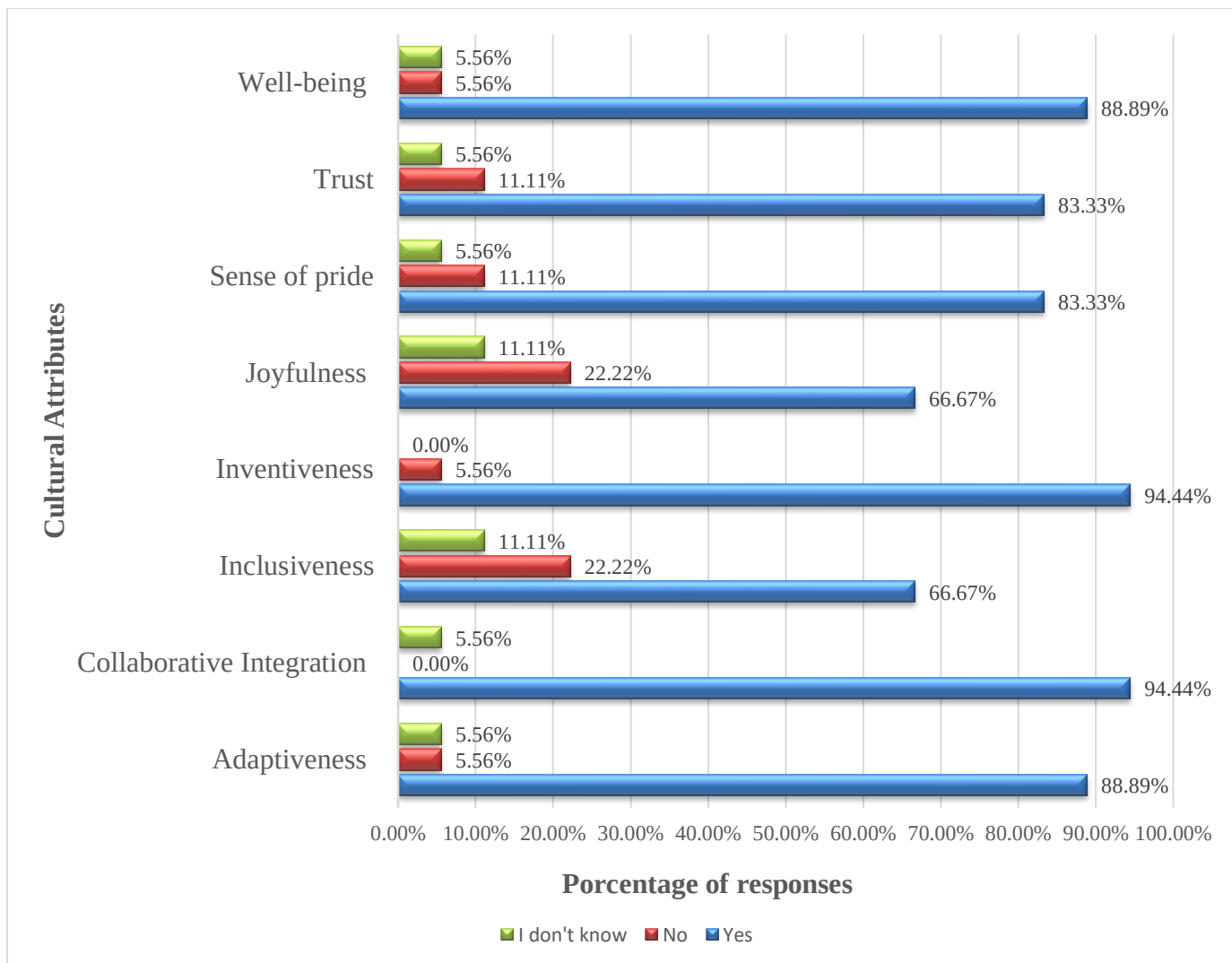


Figure G-1: Quantitative results that showcase the attributes' suitability in relation to organisational resilience.

Appendix H – Template sample of the qualitative analysis shared with participants

Qualitative analysis – Adaptiveness¹:

Description:

“The organisation is equipped with a collective ability to repurpose existing systems and behaviour as needed through proactive behaviour and a constant improvement of established ways of doing things”.

Below we showcase the group’s comments and recommendations for the attribute “Adaptiveness”.

Analysis Rationale

We have organised the group’s comments in our qualitative analysis by the following criteria:

1. Comments that challenge and refine the attributes' suitability (yellow).
2. Comments that are beyond the research boundaries (red).
3. Comments that support the attributes' suitability (green).

The comments in the yellow column “Comments that challenge and refine the attribute's suitability” will be utilised to make changes/refine the attribute’s description for the next survey round which will be sent out soon

Below you can find some comments from the researchers in response to the yellow column (table H-1) for the group’s consideration:

¹ The qualitative analysis was sent to participants via word documents that had the qualitative results of each individual attribute.

1. The idea of this attribute is to highlight the importance of challenging the effectiveness of established practices and behaviour when appropriate, given that internal and external shocks and stresses are changing in an unprecedented pace.
2. The researchers are cognisant of the need to highlight the ‘reactive’ aspect to adaptation and being adaptive. This will be considered as a key point to revise in the current description.
3. We aim to clarify the current description to account that current practices should be revised by all levels in the organisation; operational, tactical, and strategic.
4. Simulation exercises are also an important proactive initiative that contributes to the effectiveness of adaptive measures in an organisation. We will aim to reflect that in the refined description, thus highlighting the need to regularly simulate potential scenarios to allow reflection on adaptive practices.
5. What more detailed adaptation categories (if any) are important to reflect in the description of this attribute in the realm of water utilities?
6. Learning from past events, even if experienced by a different utility/organisation, may certainly support the effectiveness of adaptation initiatives.

Table H-1: Analysis of the comments from the group on the "Adaptiveness" attribute.

Comments that challenge and refine the attribute's suitability:	Beyond the research boundaries:	Comments that support the attributes' suitability:
Continuous improvement is a necessary attribute, not sure about the re use of existing systems and behaviours.	We have a [...] quality management system that enables continual improvement and a dedicated change and transformation team.	Adaptation is a key attribute to organizational resilience. If an organization does not adapt to black sky events, they will continuous fail to meeting their organizational objectives.
It is the ideal definition of organizational resilience but doesnt go far enough. It needs to include reactiveness to situations as they come up and quick adapation strategies identified.	Even though Adaptiveness is essencial for a utility's survival, the inertia associated to change may guarantee a certain stability towards changes that are not worth adapting to.	The external risk factors are growing in complexity, both on its own and in the form of combination of risk factors. Unless a water company has considered the impact of external risk factors such as supply-chain distrupction to its chemicals combined with a weather-related event

Comments that challenge and refine the attribute's suitability:	Beyond the research boundaries:	Comments that support the attributes' suitability:
		which requires more chemicals, there could be a high risk of water constraints.
In my understanding this means (in simple words) that an organisation is able to change (itself or its systems) if the need arises. this is vital. However, I have some doubts about the last part of the definition: a constant refinement of established ways of doing things sound to me like small incremental changes. If an organisation focuses too much on 'doing the present things better', this may hamper its ability to change instead of supporting it.		NEW BUSINESS AND NEW CHALLENGES (EXAMPLE PANDEMIC, ENVIRONMENTAL CHALLENGES) NECESSITATE NEW APPROACHES IN PROCESS AND ACTIVITIES (E.G. WATER REUSE ETC) NECESSITATING ADAPTIVENESS OF PERSONEL AND CUSTOMERS.

Comments that challenge and refine the attribute's suitability:	Beyond the research boundaries:	Comments that support the attributes' suitability:
i would add "...and refinement of established ways of doing things with regular exercises to ensure effectiveness of response."		I want justify my answer [not needed] but I will explain it. Our business is adapting to different operational challenges 24/7/365 that impact on our ability to deliver customer service and this is what we are her to deliver and so I would argue that it is a cultural as well as procedural thing.
Adaptive capacity/adaptiveness is critical to acheiving Organisational Resilience. It is a very broad attribute (i.e. many processes, behaviors, systems must have the capacity to adapt) and I think it's important that the wording for this attribute identify a few key categories.		essential characteristic.

Comments that challenge and refine the attribute's suitability:	Beyond the research boundaries:	Comments that support the attributes' suitability:
In reference to my response to Q5, would adjust wording as follows: The organisation is equipped with a collective ability to repurpose existing systems, adjust processes and procedures, and modify behavior as needed through a proactive approach that strives to regularly improve and refine the established way of doing things.		Repurposing of systems and resources is often important for an organization. In tough financial times, goals must often change. In emergencies, some functions are less important and resources must be shifted to new challenges.
"...a constant improvement and refinement of established ways of doing things." I read this as continuous improvement, which means the org. is always reviewing processes and finding efficiencies and improvements. This standard expectation or behavior leads to always having a handle on how.		this is very important attribute as the characteristic of a community that you serve is also changing over time. the external factors of expected water consumption, populations, industry mix and with climate change weather patterns means that assets will have varying purposes over their long life.

Comments that challenge and refine the attribute's suitability:	Beyond the research boundaries:	Comments that support the attributes' suitability:
Adaptivness is key in the longrun for a water utility. P.ex. changes in water use of the consumers dropped considerably in the past 20 years [here], that still has a major effect on the production needs. However I have to state that proactivness is not part of the adaptational prcess, tha approach is much more reactive unfortunately.		this is one of the key aspects we explore when developing our integrated resource plans.
This cultural attribute does contribute to some aspects of the organization but not all. There are some very ingrained bureaucratic systems and behaviors that are not easily changed.		Within any geographic company area there will be change over time including demographic movement of population. In order to deal with this the company will need to use adaptive means to provide the correct services using the asset base at this disposal including examining the reuse of former assets and reporposing of same.

Comments that challenge and refine the attribute's suitability:	Beyond the research boundaries:	Comments that support the attributes' suitability:
The issue is whether or not we learn from disruptive events. There are active debriefs for the more significant disruptive events. There is a takeaway to the business representatives to consider their processes and determine what changes are required to ensure that our processes are enhanced to withstand future disruptions. This is done to varying degrees, depending on the maturity of the areas of the business. If changes are not implemented to address the vulnerabilities then the benefits will not be felt.		The ability to adjust and adapt is paramount.
		Continuous improvement and adaptability is a must.

Appendix I – E-mail sent to participants requiring their participation in round 2

Thank you for all your responses and comments on the 1st round of the survey.

Based on the group's results from the 1st round we have modified the cultural attributes and their descriptions, and we would like to capture your views on the changes we made. I am sending below the link to the 2nd Survey Round which contains the modified attributes:

https://cranfielduniversity.eu.qualtrics.com/jfe/form/SV_0ugYeZogo0O3fQG?Q_DL=gI3ErOKLDNMmnuO_0ugYeZogo0O3fQG_MLRP_ekDsT0L52gWcA0S&Q_CHL=gl

Please note that based on the quantitative results, the attributes "Inclusiveness" and "Joyfulness" did not manage to reach the cut off criteria of 80% consensus on their suitability in relation to organisational resilience, therefore they were **removed** from the framework. In addition, we attempted to reflect your comments wherever possible to refine the remaining attributes' description.

Could you please conduct this modified survey by clicking on the link above?

If you do not understand any of the questions or if you are unsure about anything, please do not hesitate to get in touch!

Many thanks again,

Eduarda

Appendix J – Evidence table and mind map relating to themes from chapter 2.

Table J-1: Evidence table illustrating the themes, sub-themes, participants' quotes and the number of respondents whose transcript contains in the respective sub-theme.

Theme	Sub-theme	Example quotes	n
Narrow understanding of resilience.	Perception of resilience as robustness.	<i>"To me, 'resilience' means being able to withstand, in terms of climate change, being able to withstand both these chronic stressors and also the acute stressors that will arise"(RI17).</i>	5
	Perception of resilience as risk management.	<i>"Well, I tend to talk about things more in terms of risk. I believe resilience is very closely related to that" (RI16).</i>	8
	Confusion of what resilience is.	<i>"In terms of the term 'resilience', I think there can be confusion now between what's the difference between resilience versus sustainability? There are all these terms that get thrown around" (RI17).</i>	4
	Perception of resilience as rapidity.	<i>"I think enterprise resilience, it's the same as enterprise risk management, and it means that the risk that you report on reflects activities right across the business" (RI08).</i>	1
	Fatigue factor around resilience.	<i>"[...] there is a little bit of a fatigue factor I would say, going on, in the industry at the moment, because of the number of conversations we are having in the resiliency space" (RI11).</i>	2

Justifying and sustaining resilience	Reactive behaviour.	<i>"“[...] you are functioning on a daily basis in a reactive mode. [...] I think a lot of people, they have a lot on their plate, so it's like how much additional capacity do they really have, realistically, to be engaged in longer-term efforts?” (RI17).</i>	7
	Justifying resilience measures based on hypothetical scenarios is a challenge.	<i>"I think if it's not an immediate threat it's hard to raise that importance level of projects such as that" (RI10).</i>	5
	Justifying resilience is easier during and after a disaster event.	<i>"Nothing speaks to people more than an extreme weather event. That really sharpens the mind" (RI02).</i>	5
Constrained environment for innovation.	Uncertainties and scarce resources hinder experimentation.	<i>"[We] want to be – accountable for every penny we spend, it's led to a culture of, kind of... It's fairly risk averse, right? We tend to do things that are tried and true" (RI06).</i>	7
	Reluctance to change by personnel.	<i>"I think one of my struggles is to get... to shift my internal culture to resilience. People will hear it and hear me talk about it and then just go back to doing things the same way that they've done it. So I think what needs to happen is taking a proactive versus a reactive approach" (RI05).</i>	7
Resilience and resources.	Lack of financial resources.	<i>You'll get barriers like a lack of resources. "We can't afford to do this." Resilience is just adding the extra costs' (RI01).</i>	14
	Lack of organisational resources.	<i>"I think it's usually just a resource issue, that someone is just not assigned that or given the resources needed to do that" (RI16).</i>	6
	Resilience not seen as a basic necessity.	<i>"I would say that resilience is another level. Then you are focusing on the future, then you would like to increase those aspects that are not essential, necessarily, for your everyday life as an enterprise. Now, for us, it's too urgent, the everyday problems" (RI18).</i>	5

Silos and conflicting priorities.	Recognition of silos.	<i>"I guess it's the old question of silos. That word really, really summarises. People really are focused in. [...]" (RI13).</i>	9
	Physical structures.	<i>"I mean, firstly, I think large organisations almost inevitably tend to end up operating in quite a siloed manner at times. So, there has to be some way of linking those discussions around enterprise resilience right the way across an organisation to kind of truly get that integrated approach to resilience" (RI03).</i>	5
	Technical background.	<i>"There is not a cross fertilisation across functions and there needs to be, absolutely needs to be" (RI07).</i>	6
	Hierarchical levels.	<i>I also see this a lot amongst the upper management level of the company. We need resources and the company says: "that is not a priority right now, our priority is something else. I won't spend this budget in this region because it is too small, let's allocate this budget somewhere else more profitable." This difference is what hinders our work a bit in this sense, from our operational perspective' (RI15).</i>	4
Uncertainty on leadership buy-in.	Leadership.	<i>"Our charter for the board of directors says that they have oversight over risk, but they don't actually name resilience in the board charter" (RI08)</i>	5
	Political influence.	<i>"Then political changes. As I said, we have shareholders, those are public bodies, and public bodies tend to get elected once in a while. Also, [...] there has been a more populist movement coming up. That's one side of the coin" (RI20).</i>	7
Organisational structures.		<i>"Typically, I guess, people get tasked with their own unique set of tasks and programme goals, but it's unusual that there's another group that's tasked with looking at all sectors of the department or utility" (RI16).</i>	8

Lack of understanding on how to embed a culture of organisational resilience.	Need to recreate the organisational culture.	<i>"My culture has to change. It's always going to be a continual journey but if we just stand still, we'll be behind the times within a week. It's the whole thing about change. I know change is difficult for a lot of people but they need to understand why change and why we need change and what our goals are" (RI07).</i>	7
	Leadership.	<i>"[...] we've been working with since we had a new general manager come in. [...] It's a spirited workplace culture. [...] It's about fostering pride in your workplace. It's inclusion and it is [...] respect, innovation, and then trust" (RI06).</i>	9
	Policies and structures.	<i>"As well as the culture, you also, obviously, need the underpinning strategies, processes and procedures that make sure that that culture flows from whoever's starting it at the top, all the way through down into the business, down into day-to-day operations. Then you've got to make sure you've got the right structures, processes, policies and procedures in place, as well, to make that happen" (RI02).</i>	2
	Post crisis.	<i>"[...] last year for us was a very, very dry year and we went through a period where we were most certainly in a drought, and the water resources available to us were a lot lower than they would be in typical years. And, actually, what that did was kind of force different parts of the organisation together, and to work together in a way that probably they hadn't done since our last major drought in the mid-1990s" (RI03)</i>	2
	Empowerment.	<i>"So there has to be an open and transparent culture in which you can discuss about mishaps, but you can also discuss about the results that you promise to deliver. The company culture and the company openness is the important factor in resilience in terms of employees [...]" (RI20).</i>	6
	Trust.	<i>"One has to be able to trust its employees, obviously, and one must have the trust of its employees" (RI20).</i>	5

	Sense of pride.	"We want our employees to feel proud of where they work, right? When you have that – that pride and that kind of 'stick-to-it-ness', and, when we go through times of crisis, that people really band together – it just is phenomenal how much, I don't know, I guess pride and culture it builds, right?" (RI06).	2
	Integration and collaboration.	"We talk about corporate risk. It's improving but there is more to do. A lot of it is about culture and integration and people behaviour" (RI07).	8

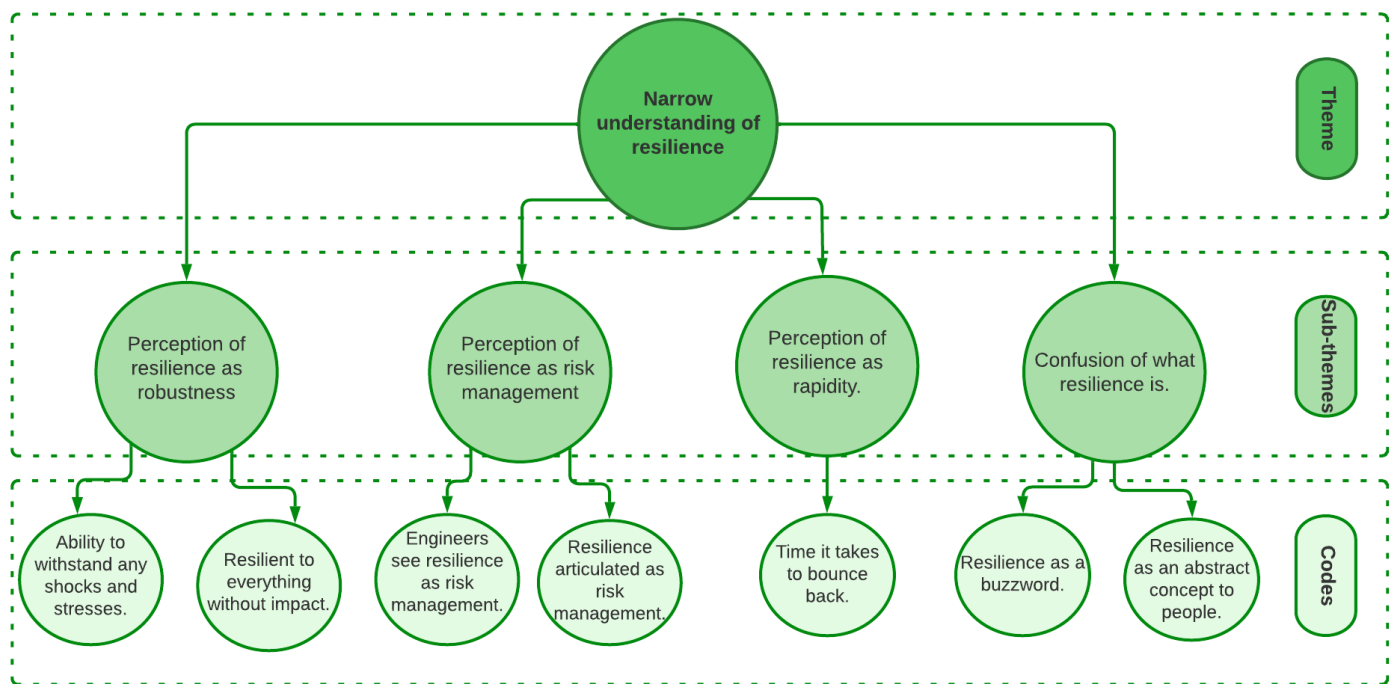


Figure J-1: Example of the thematic mind-map to evidence the hierarchical order of codes, sub-themes, and theme.