Opening the Black Box: Examining How Public Sector Organizations Interpret and Respond to Extreme Weather Events Risks

by

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ABSTRACT

This research investigates how public organizations interpret and respond to the threats they face. Drawing on the open interpretative framework and progressing through its stages (i.e., data collection, interpretation, and action-taking), the three studies of the dissertation build on each other to examine how US public transit agencies deal with the risks posed by extreme weather events. The first study analyzes the "data collection" stage and draws on information processing theory to investigate how various sources of information shape public agencies' risk perceptions. Integrating administrative data with a 2019 survey of US transit managers, results show that reliance on scientific sources of information is positively associated with perceived risk of extreme weather events. The effect of contracting on risk perceptions is contingent upon agencies' outsourcing strategies. The second study expands on the first one and focuses on the "interpretation" stage, examining how organizations cultivate a shared perception of extreme weather events. Analyzing in-depth semi-structured interviews with public managers employed at four transit agencies, the study identifies and describes three processes that foster the development of intersubjective interpretations: conversation, suppression, and shared experiences. Informed by the findings of the first two studies, the third one examines the role played by organizational interpretative processes in enabling the undertaking of adaptive actions. I test my expectations using data coming from a follow-up 2023 national survey of public transit managers. Findings underscore the importance of "debative cooperation" and cross-agency boundary-spanning activities in facilitating the development of shared cause maps and favoring adaptation. Overall, the dissertation

provides an integrated and comprehensive investigation of the organizational and social elements that shape effective risk management and adaptation to extreme phenomena.

DEDICATION

To Agnese, I love you.

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This dissertation and my entire PhD journey epitomize the essence of the saying, “it takes a village to raise a child”. None of my accomplishments would have been possible without the continuous support of a village of individuals and professionals who have stood by me every step of the way. I would like to thank my family, whose unwavering support has been my cornerstone. They listened patiently when I needed to talk, motivated me when I faltered, and enveloped me with love. They are my role models, and their encouragements, smiles, and patience fueled my journey from the very beginning. Without their support, I may never have embarked on this path.

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TABLE OF CONTENTS

CHAPTER Page

LIST OF TABLES

Table Page

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

We live in the "risk society" (Beck, 1992). Risk, defined as the possibility of experiencing a loss, (Tierney, 2014) characterizes multiple aspects of our existence, from the technological to the environmental, from the sanitary to the financial. New risks emerge continuously, often span national and governmental boundaries, and require both public and private organizations to put in place effective actions to forecast, avoid, minimize, and respond to the operational, financial, and reputational threats they face (Ansell et al., 2010; Boin & Lodge, 2016). In particular, public sector organizations are under increasing pressure to effectively manage the issues challenging our society, ensure service provisions, and act as "the ultimate bearer of societal risks" (Roberts, 2020, p. 603).

The increasing pervasiveness of risks within society, brought some authors to posit that uncertainty, ambiguity, and instability are now the "new normal" (Roberts, 2020; Tierney, 2014). Nonetheless, despite the growing attention the public and popular press pay to risks (Abrams, 2022; Metz & Schmidt, 2023), research and practice have increasingly examined threats from a technical and professional perspective, often overlooking their social dimension and how it can contribute to enhance or reduce the hazards faced (Boin & Lodge, 2016; Tierney, 2014). For instance, in 2016, the White House Office of Management and Budget (OMB) released Circular No. A-123[1] mandating the implementation of formal risk management programs across all

[1] https://www.osec.doc.gov/opog/privacy/Memorandums/OMB_Circular_A-123.pdf

departments and agencies in the executive branch. While technical design and professionalism are important elements that can contribute to achieve a risk-free environment (Zahran et al., 2008), they are per se insufficient if not adequately supported by a thorough understanding of organizations' social dimensions ('t Hart, 2013).

However, studies examining the social dimension of risk have primarily focused on theorizing about individual judgments (e.g., analyzing heuristics, biases, and risk aversion) (Kahneman et al., 2008; Roberts & Wernstedt, 2019) or systems interactions (e.g., investigating how tight and loose coupled subsystems may foster disaster diffusion) (Perrow, 1984), with less research analyzing organizations (either public or private) (Gephart et al., 2009; Gould, 2021). Yet, many risks originate from organizational behaviors, and organizations are significantly affected by risk occurrences (Gephart et al., 2009). Additionally, organizations are often established to address hazards, as they are much more effective than single individuals in managing these issues (Gephart et al., 2009; Scott & Davis, 2007). Thus, examining organizations and how they deal with hazards can provide some insights on how to minimize the emergence of risks and their impacts.

Moreover, studying public sector organizations and how they perceive, manage, and respond to risks contributes to inform public management research and practice. From a research perspective, public administration scholars have called for more extensive theoretical work aimed at examining how public agencies prepare, address, manage, and respond to threats ('t Hart, 2013; Boin & Lodge, 2016; Bullock et al., 2019), suggesting that literature investigating how agencies perceive and prepare for the threats

they face is still scant (Zhang, 2022). With regards to practice, public sector organizations are increasingly required to effectively address emerging and established hazards (Roberts, 2020), hence, an analysis of the processes that could improve public agencies' effectiveness in managing threats may help them in minimizing the challenges these issues pose.

Drawing on social psychology theories, decision-making literature, and preparedness scholarship, this dissertation studies public agencies as "risk perceivers". Specifically, I investigate the role organizational perceptions of risk play in shaping how agencies plan for and respond to the climate-driven threats they face by answering the following research questions: *Which elements determine agencies' perceptions of the environment? How do public agencies cultivate a shared perception of extreme weather events risks? Why are some organizations more likely to learn and adapt to extreme weather events? What is the role played by internal processes in fostering or preventing adaptation from occurring?*

The next section provides a definition of organizational risk perceptions, I then introduce the type of risks I am studying (i.e., extreme weather events) the organizations of focus (i.e., US public transit agencies) and the theoretical framework that guides the dissertation. I conclude the introduction presenting the structure of the dissertation and its contribution.

Organizational perceptions of risk

Organizational perceptions of risks are judgements on organizational exposure to hazards resulting from agency-level interpretative processes (Caldarulo & Welch, 2023;

Renn, 1998; Weick & Sutcliffe, 2006). While these judgments are collectively held by managers and result from organizational internal processes (Daft & Weick, 1984; Weick et al., 1999; Weick & Sutcliffe, 2006), research mostly studies organizational perceptions of the external environment as given or as influenced by factors exogenous to the organization. For instance, Wachinger and colleagues (2013), in their review, identify four main determinants of risk perceptions, none of which is related to the interpretative processes Weick and colleagues (1999) suggest could prevent organizations from experiencing disasters.

This disconnect may stem from what organizational scholars have defined as anthropomorphism: the extension of individual phenomena to organizations, without considering the social dimension of these entities (Walsh & Ungson, 1991). In the case of organizational risk perceptions, anthropomorphism led some literature to assume that organizational cognitive processes are the same as those of individuals (Ott & Shafritz, 1994). Consequently, research applied psychological theories such as prospect theory and heuristics to organizations. Additionally, studies treated organizations as monolithic entities, overlooking the fact that multiple risk perceptions exist within a single organization and that internal dynamics and processes influence organizational perceptions of risk (Barke & Jenkins-Smith, 1993; Daft & Lengel, 1986; Dobbie & Brown, 2014; Ungson et al., 1981).

One way to address anthropomorphism is to view organizations as interpretative systems (Walsh & Ungson, 1991). This approach recognizes that even though individuals' subjective assessments influence organizations' understanding of the

environment, it is actors' interactions, decision-making processes, cognitive diversity, and power dynamics that ultimately shape how agencies interpret their operational domain (Crossan et al., 1999; Daft & Huber, 1986; Daft & Weick, 1984; Hambrick & Mason, 1984). Put it differently, according to the organizational interpretative approach, organizational risk perceptions are not the mere sum of individual interpretations as the processes governing these two phenomena are related but distinct (Crossan et al., 1999; Daft & Lengel, 1986).

Both organizational and individual perceptions of the environment involve the assessment of uncertain and ambiguous information (Daft & Weick, 1984). However, while individuals often rely on heuristics to construct an approximate yet satisficing understanding of their operational domains (Simon, 1972; Tversky & Kahneman, 1974), within an organization, actors must go beyond this and explicitly communicate their perceptions to other members for collective action to follow (Crossan et al., 1999). This process entails the development of a common language that creates shared understandings, reduces both ambiguity and uncertainty, and addresses some of the biases inherent in heuristics judgements (Daft & Lengel, 1986; Daft & Weick, 1984; Weick, 1995).

Based on the above, this dissertation studies organizations as open interpretative systems, recognizing that organizational risk perceptions are the result of internal organizational processes (Daft & Weick, 1984; Weick et al., 1999; Weick & Sutcliffe, 2006). Hence, it examines how internal dynamics, cognitive differences, and

relationships with external actors influence the development of shared perceptions of threats and drive adaptation to extreme weather phenomena.

I examine organizational perceptions of risk as these phenomena heighten the perceived salience of issues or events, and increase the likelihood that an organization will take action to respond to them (Bundy et al., 2013). Organizational risk perceptions play a pivotal role also in shaping an organizations' operations, as they inform management's priorities and guide their actions by identifying risk tolerability criteria, and designing the strategies to address threats (Dobbie & Brown, 2014; Renn, 1998). Moreover, they are key elements shaping how organizations understand and respond to extreme weather threats as they can trigger sensemaking processes and motivate the enactment of preemptive and adaptive strategies (Wachinger et al., 2013; Xiang, 2021; Zhang, 2022).

Extreme weather events

Among the risks faced by public sector organizations, I focus on the threats posed by extreme weather events. Extreme weather events are climate occurrences that are more severe, inconsistent, and damaging than what has been observed historically, and are increasingly exacerbated by climate change (Estrada et al., 2023; IPCC, 2012). Extreme weather events are particularly daunting because they challenge the prevailing organizational structures as organizations often fail to quickly respond to them (Zhang & Welch, 2022). Hence, they represent a major source of alarm and are considered among the "biggest threats modern humans have ever faced" (UN, 2021; WEF, 2022).

Extreme weather events pose serious threats especially for public agencies' operations and survival. Public agencies are required to provide reliable services in an unstable environment, ensure the capacity for sustained peak performance, and guarantee the safety of citizens. Failure to meet these targets has political, financial, reputational, and legal consequences which can halt agencies' existence (Boin & Lodge, 2016; Boin & van Eeten, 2013; Moynihan, 2012). For example, in the aftermath of Hurricane Katrina, both the Department of Homeland Security (DHS) and the Federal Emergency Management Agency (FEMA) were under scrutiny, leading to top management resignations and proposals to separate FEMA from the DHS (Moynihan & Roberts, 2010; Wise, 2006).

While failure to prepare for and adapt to extreme weather raises managerial concerns for public agencies, public sector organizations often find themselves ill-equipped to anticipate and manage these environmental threats (Zhang & Welch, 2022). Two of the main impediments to adaptation to extreme weather are the *ambiguity* and *uncertainty* characterizing these phenomena (Daft & Lengel, 1986; IPCC, 2012; Zhang & Welch, 2022). Uncertainty represents the extent to which information is absent, while ambiguity implies that information are ill-structured (Daft & Lengel, 1986).

Uncertainty exists about "when" these events will occur, "where" they will hit, and "how" severe and frequent they will be (Markolf et al., 2019; Zhang & Welch, 2022). For instance, while research shows that climate change is causing Europe to experience more frequent and severe heatwaves, we lack precise forecasts regarding the timing, most affected countries, and duration of these events. As a result, European governments have

been caught unprepared and slow to respond to these phenomena, leading to the death of over 61,000 individuals in the sole summer of 2022. (Pianigiani, 2023; Rousi et al., 2022).

Ambiguity around extreme weather stems from the lack of understanding about the direct and indirect consequences that these events will have on social and institutional systems (Markolf et al., 2019). To this extent, extensive droughts and heatwaves not only impact water and energy consumption but can also disrupt global food production, fuel mass migrations, foster conflicts, and spread infectious diseases, straining governments' efforts to plan and adapt to these phenomena, as extreme weather direct and indirect consequences permeate all aspects of society (Jägermeyr et al., 2021; Lustgarten, 2020).

Since agencies often lack the capacity to deal with both uncertainty and ambiguity they tend to rely on past experiences and anecdotes to make sense of the environment and guide their behaviors (Nowell & Stutler, 2020; Roberts, 2020). However, past actions and experiences may not be adequate to inform decisions on how to prepare for phenomena that are becoming more and more frequently unforeseen "one-in-a-century" events (Nowell & Stutler, 2020). An excessive focus on the past also causes agencies to be affected by normalcy biases, shared beliefs that bring organizations to underestimate the threats they are facing, reducing their preoccupation with failure, and inducing inertia (Weick et al., 1999; Zhang, 2022). Consequently, this dissertation is motivated to understand the organizational processes which may address environmental uncertainty and ambiguity, influence organizational perceptions of risk, facilitate a collective understanding of the environment, and foster adaptation to climate change.

The context: US public transit agencies

Public transit agencies are an ideal context for this study because of their characteristics, their exposure to extreme weather, their geographic dispersion, as well as their variation with regards to the modes of service provided, governance structures, and outsourcing strategies. All these factors can influence organizational perceptions and responses to extreme weather risks.

Transit agencies meet both the conditions that Perrow (1984) suggests make an organization more likely to experience accidents: interactive complexity and tight coupling. Interactive complexity refers to the interconnectedness of organizational elements, while tight coupling signifies that events in one unit directly impact other subsystems (Pidgeon, 2011). Transit agencies are interactively complex as they are tasked with building infrastructure and managing diverse mobility service systems that are highly dependent on technology (McElveen, 2012). Consequently, these agencies employ a spectrum of professionals who interpret risks through their own functional backgrounds, leading to varying interpretations of the external environment that need to be reconciled (Dobbie & Brown, 2014; Eisenhardt et al., 1997).

Transit agencies are tightly coupled systems since the technological complexity characterizing their machineries and the specialized knowledge required to handle them limit the number of alternative arrangements operators can make in case of malfunctioning (Perrow, 1994). Similarly to what occurs in other tightly coupled organizations, small weather-caused breakdowns have cascading effects, leading to system-wide failures (FTA, 2010; Markolf et al., 2019; Perrow, 1994). For instance, in

August 2020, Scotland experienced an intense storm that brought nearly a month's worth of rainfall in just three hours. Because of the unprecedented volume of water, the railway's drainage system failed to properly work, causing debris to accumulate on the tracks of the railway connecting Dundee and Aberdeen, two of the most populous cities of the country. Tragically, a train derailed as a result, causing several casualties and the disruption of the railway line's transit for several months (Topham, 2022).

Another element that makes transit agencies an ideal context to study risk perceptions of extreme weather events are their infrastructural characteristics. Transit agencies' fixed assets (e.g., railways, bus shelters) are exposed to weather conditions, a feature that makes them prone to be damaged by the increasingly severe extreme phenomena that are taking place (Markolf et al., 2019; Miao et al., 2018). This condition is further exacerbated by the well documented underfunding of transit infrastructure which is in poor or marginal state of good repair and which exposes agencies to the risk that adverse weather conditions could seriously impair their operations and finances, and, more importantly, the safety of both passengers and employees (FTA, 2010; Miao et al., 2018).

Transit agencies are geographically dispersed exposed to different types of extreme weather events (e.g., hurricanes and wildfires) (APTA, 2021). Transit agencies vary with regards to the areas they serve, their governance structures, and the operating modes they have in place. Since they serve different contexts transit agencies also interact and respond to different groups of stakeholders, whose values, preferences, and priorities, will influence agencies' risk perceptions and preferences (Hotimsky et al., 2006; Rainey,

2009). Moreover, transit agency leadership, often appointed or elected, will presumably be influenced in their perceptions and priorities by the political environment in which they operate (Hotimsky et al., 2006).

Agencies also vary in their ownership and funding structures (Bozeman & Bretschneider, 1994; Rainey, 2009). Some agencies are part of larger regional transportation authorities or metropolitan planning organizations (e.g., Chicago RTA, San Diego Association of Governments), others are independent agencies (e.g., Toledo Area Regional Transit Authority, Utah Transit Authority), yet others are managed by cities or counties departments of transportation (e.g., Suffolk County Transit, City of Visalia). Depending on agencies' ownership and funding structure, managers may have different levels of autonomy in addressing the threats they face. Finally, US public transit agencies also vary with regards to their reliance on Federal, State, and local grants rather than fare revenues[2], an element that can influence their priorities as well as their understanding of the environment (Pfeffer & Salancik, 1978).

Another source of variation characterizing public transit agencies in the US lies in the service modes they have in place (e.g., bus, light rail) and the extent to which they directly operate their services. Each service mode has its own right-of-way, technology and operational features (FTA, 2020). Each service mode has also a different level of exposure to extreme weather. Some agencies simply perform simple services like demand response while others have in place complex infrastructures such as monorails, or aerial tramways that tend to be more vulnerable to extreme weather (FTA, 2020).

[2] https://www.transit.dot.gov/ntd/data-product/2021-annual-database-uza-sums

Complexity may stem also from transit agencies' outsourcing strategies (Cao & Lumineau, 2015; Comfort, 2007; Roehrich et al., 2020). While some organizations perform all their tasks in-house, others entirely rely on contractors (see the first study for a more detailed discussion) (APTA, 2021). The different level of complexity characterizing the various types of service modes provided and the contracting strategies in place may contribute to some agencies being more exposed to the threats posed by extreme weather events (Perrow, 1994).

The theoretical framework: Public transit agencies as interpretation systems

To study how US public transit agencies interpret and address the risks posed by extreme weather events, I adapt the three stages through which Daft and Weick (1984) suggest organizations perceive, make sense, and respond to the environment: *data collection*, *interpretation*, and *action-taking*. The similarities existing between Daft and Weick conceptualization of organizations and US public transit agencies provides a fruitful theoretical venue to examine how these organizations make sense of their environments and perceive and respond to the risks that stem from them.

The first element shared by US public transit agencies and Daft and Weick organization is that they both are **open systems** that need to deal with ambiguous and uncertain information to navigate the environment in which they operate (Pfeffer & Salancik, 1978). Furthermore, both Daft and Weick organization and transit agencies put in place strategies aimed at addressing information complexity, which, however, can shape how the environment and extreme weather are perceived (Daft & Lengel, 1986).

The **focus on organizations' interpretation and enactment of the environment** is the second element that makes Daft and Weick framework suitable to examine transit agencies. While both managers and organizations receive and interpret information from the environment, the process through which agencies develop perceptions of risks is more complex and involves a greater amount of tasks (Daft & Lengel, 1986; Ungson et al., 1981). Managers interpret the same information through their own mental models, and, for this reason, similarly to what happens in transit agencies, within the same organization there is an heterogeneity of perceptions which do not necessarily align with each other (Daft & Weick, 1984; Dobbie & Brown, 2014). As a result, achieving an organizational understanding of the environment requires a series of "communication cycles" and processes through which individuals' mental models are shared and integrated into a collective understanding of the environment that triggers agencies' actions (Weick, 1969). The dynamics of these processes as well as their effectiveness is one of the topics examined in this dissertation.

The third commonality existing between Daft and Weick organization and US public transit agencies stems from **the role environmental and organizational elements play in shaping organizational interpretation and outcomes**. Similarly to what posited by Daft and Weick (1984), also US public transit agencies' actions and understanding of the environment are influenced by both the context in which they operate and the processes they have in place. For example, agencies dealing with extreme weather events characterized by slow onset rates, such as those experiencing the gradual rise of sea levels, have perceptions of the risks entailed by extreme weather much different than

those dealing with abrupt phenomena such as hurricanes (Zhang, 2022). Moreover, Poister and colleagues (2013) demonstrate how transit agencies that design internal processes aimed at developing strategic planning have significantly better performance than those that adopt incrementalistic decision-making processes.

To sum, the characteristics of public transit agencies, as well as the context in which they operate make Weick and Daft's framework suitable to study how public agencies perceive and respond to the threats extreme weather events pose. Next, I briefly outline the three stages through which Daft and Weick theorize agencies make sense and respond to the environment and describe how each of the studies of the dissertation focuses on each of them.

The three stages of the framework

Daft and Weick suggest that agencies navigate task and environmental complexity following a three-stages process: data collection, interpretation, and action-taking. **Data collection** is the first stage of the model. During this stage organizations that need to make sense of ambiguity and uncertainty, scan the environment and collect information to develop a preliminary perception of it (Daft & Weick, 1984). The level of uncertainty and ambiguity organizations need to make sense of and the types of information they rely upon will influence their perceptions of the external environment (Daft & Lengel, 1986). For instance, relying on media able to convey rich information and immediate feedback such as in-person meetings with vendors or scientific analysis support agencies in having access to more data and structuring the information available, ultimately reducing both uncertainty and ambiguity (Daft & Lengel, 1986).

In the first study of the dissertation, I examine the data collection stage drawing on Information Processing Theory (IPT) to examine how different sources of information may shape public transit agencies' perceptions of the risks posed by extreme weather events.

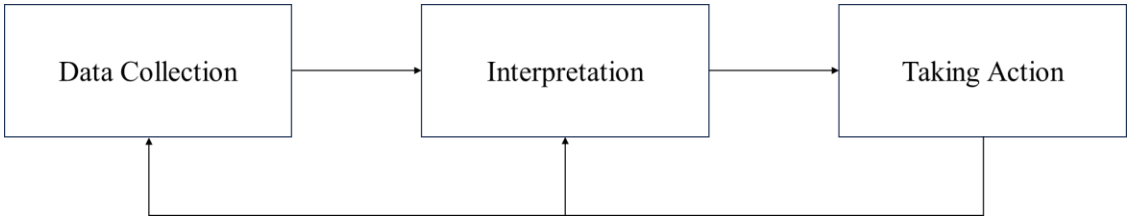
Interpretation is the second phase of the process through which organizations understand and respond to their environment. During this stage the data collected in the first phase and the resulting understandings are given meaning (Daft & Weick, 1984). Managers within the organization gather, share their causal maps (i.e., interpretations), and develop a collective perception of the environment. This stage consists in multiple "communication cycles" through which differences are handled to develop collective organizational meanings (Weick, 1969). While the idea behind this description is straightforward, less clarity exists with regards to the mechanisms through which these processes unfold when agencies develop interpretations of future events (Gephart et al., 2010). To this extent, literature extensively presents managers and organizational leaders as the actors involved in this process, discussing their use discursive practices to develop a shared understanding of the environment, (Abolafia, 2010; Brown et al., 2008; Cornelissen, 2012), but provides less focus on the actual mechanisms through which these processes unfold (Maitlis & Christianson, 2014; Maitlis & Lawrence, 2007). For this reason, the second study of the dissertation draws on interviews of public managers to explore the mechanics of these processes in public transit agencies dealing with extreme weather events.

The last stage of Daft and Weick framework is **action-taking**. If the first two stages of the model have been effectively managed, they will result in consensus around a collective understanding of the environment and, thus, in a response to the threats faced (Crossan et al., 1999; Fiol, 1994). In this stage, the organization that has effectively managed the uncertainty and equivocality shows adaptability, being able to design and enact processes that make it more likely to survive the environment in which it operates (Fiol & Lyles, 1985; Weick, 1969).

While Daft and Weick framework refers to adaptation from a Darwinian perspective, the third study aligns with environmental scholarship, defines adaptation as "intentional changes made […] to reduce the anticipated climate change impacts" (Miao et al., 2018, p. 253), and examines why some public agencies are more likely to adapt than others and how the interpretation stage and cognitive heterogeneities can influence agencies' adaptability.

Figure 1 represents the three stages of the framework and how they influence each other reciprocally through a series of feedback loops. The actions taken by the organization and their outcomes serve as a source of data that agencies analyze and use to further inform their perceptions of the environment. Moreover, feedback resulting from these actions may provide new insights for top managers during the interpretation stage, supporting agencies' sensemaking process.

Figure 1: Daft and Weick three-stages framework



The structure of the dissertation

The dissertation applies Daft and Weick framework to study the three stages through which US public transit agencies perceive, assign meaning, and respond to the risks posed by extreme weather events. I examine these stages using two waves of national surveys administered to the largest transit agencies in the US and interviews with middle and top transit managers.

The three studies

The first study examines the **data collection** stage. I integrate IPT with contracting scholarship to answer the following research question *How do scientific information and contracting influence public transit agency perceptions of extreme weather risk?*

Using 2019 survey data, I run a mediator model and find that scientific information reduces both the uncertainty and ambiguity agencies face, increasing organizational risk perceptions of extreme weather events. Results also suggest that the effect of outsourcing on agency sensemaking capacity is contingent upon the contracting strategies it has in place (Karaba et al., 2022; Kinder & Burgoyne, 2013).

In addition to extending IPT to public sector organizations dealing with extreme weather phenomena, results also validate one of the assumptions underpinning Daft and

Weick framework (1984). Specifically, by revealing multiple risk perceptions within the organization, the study empirically confirms the complexity of organizational interpretations compared to individual ones (Daft & Lengel, 1986). This finding not only underscores the solidness of Daft and Weick framework as the theoretical foundation of the dissertation but also raises questions into the mechanisms by which discrepant perceptions are integrated to develop shared interpretations of the external environment. As a result, the second study integrates the first one, looks at the **interpretation** stage, and answers the following research question: *How do public agencies cultivate a shared interpretation of extreme weather events risks?*

I answer this questions exploring the mechanisms through which cognitive differences (i.e., heterogenous risk perceptions) are reconciled to develop collective organizational meanings. To do so, I conduct semi-structured interviews with transit managers, thematically coding them (Miles et al., 2020).

The analysis of these interviews identifies three main mechanisms through which agencies handle risk perception heterogeneity: conversation, suppression, and shared experiences. Findings also show that the characteristics of individuals involved in these processes influence them, with authority and organizational politics emerging as significant factors shaping the unfolding of the interpretation stage.

The third study examines the **action-taking** stage. Drawing from organizational learning scholarship (Chen et al., 2005; Crossan et al., 1999; Fiol, 1994; Weick, 1969), I analyze how decision-making processes, cross-functional collaborations, boundary-spanning activities, and heterogeneous risk perceptions may foster adaptation to extreme

weather phenomena. Specifically, I answer the following research questions: *Why are some organizations more likely to learn and adapt to extreme weather events? What is the role played by internal processes in fostering or preventing adaptation from occurring?* In the study I particularly focus on the themes that emerged from the interviews, as they informed both the hypotheses I test and the instrument I designed and administered to transit managers in 2023. I integrate managers' answers to the survey with weather data and test my hypotheses running two logit models. Results suggest that agencies that value open discussions and are characterized by reduced level of cognitive differences are more likely to adapt to climate-driven risks. Conversely, absence of internal discussions is found to reduce the likelihood that action is taken to address the challenges posed by extreme weather event. Findings also underscore the importance of organizational cultures promoting cross-agency boundary-spanning activities as this may contribute to the integration of different perspectives and facilitate adaptation to climate change.

Contributions

This research contributes to public management and risk management scholarship both theoretically and empirically. Theoretically, it examines the social dimension of environmental risks, having public sector organizations as units of analysis. The dissertation also recognizes and theorizes on the cognitive heterogeneity that exists within organizations and how it may influence their adaptation to extreme weather events (Dobbie & Brown, 2014). Additionally, it extends the application of Daft and Weick

framework, along with the socio-cognitive theories it entails (e.g., IPT), to US public transit agencies dealing with extreme weather events.

Empirically, using both quantitative and qualitative data allows a better understanding of the internal dynamics that foster organizational sensemaking as well as of the mechanisms that facilitate the undertaking of adaptive solutions. Finally, the dissertation has implications for public agencies. By highlighting the importance of designing processes aimed at achieving a thorough and collective understanding of the hazards faced, this research offers valuable insights for organizations that wish to improve their adaptability to climate change.

Contribution to theory

Risk management literature distinguishes between the technical dimension and the social dimension of risk. While technical assessments of risks are necessary for objectively measuring the consequences of extreme weather events on organizations' structures, finances, and operations, they may fail to explain suboptimal adaptive decisions as they overlook the social dimension of risk and how it affects decision-making processes ('t Hart, 2013; Bullock et al., 2019; Gould, 2021). By applying the Daft and Weick framework to examine public transit agencies as open interpretative systems, this dissertation contributes to the risk management literature and underscores the importance of designing internal processes that promote climate change adaptation.

In extending Daft and Weick framework to public agencies that need to makes sense of extreme weather risks this dissertation also provides an opportunity to study public agencies as risk perceivers (Gephart et al., 2009; Gould, 2021). Public

management research on hazards mostly has individuals as units of analysis. By building on heuristics scholarship and psychological theories, extant research investigates public managers' sensemaking processes in uncertain situations, finding the determinants of individuals' decision-making and the biases that can influence it. For instance, Roberts and Wernstedt (2019) draw on the prospect theory and find that emergency managers' perceptions and assessments are subject to biases. Similarly, Tangsgaard (2021) explore the role of organizational cultures in influencing public managers' behaviors in risky situations. By shifting the focus to organizations, this research addresses calls for more theoretically informed work on risk management within public sector organizations ('t Hart, 2013; Boin & Lodge, 2016; Bullock et al., 2019) and contributes to understanding how public agencies, as collective entities, perceive and respond to extreme weather risks.

Empirically, the dissertation contributes to the existing literature on risk management as it relies on both quantitative and qualitative methodologies. Quantitative analyses are useful to test hypotheses on both the antecedents and consequences of extreme weather events' risk perceptions. Conversely, the qualitative approach used in the second study allows to integrate the findings from the first manuscript, explore the mechanisms characterizing the interpretation stage, inform the instrument used in the third, and uncover some relationships that survey questions may not be able to explain and explore (Marshall & Rossman, 2016). Integrating quantitative and qualitative methods contributes to existing literature on organizations dealing with risk by providing a better understanding of the cognitive differences existing within public agencies and

how they are handled and integrated to develop a shared and collective organizational perception of risk (Maitlis & Christianson, 2014; March & Simon, 1993). Finally, using both methodologies provides a nuanced understanding of the processes through which public transit agencies perceive, interpret, and respond to natural hazards, as well as the mechanisms shaping agencies' adaptive capacity (Weick, 1969).

Contribution to practice

The dissertation contributes to practices by reaffirming the crucial role of the social dimension of risk within agency operations. Over the past decades, there has been an excessive focus on the technical aspects of risk, leading public agencies to treat risk management as a mere compliance obligation, overly formalized and often outsourced. (Carlsson-Wall et al., 2018; Gephart et al., 2009; Palermo, 2014). By acknowledging threats' social dimension and demonstrating that it is not the risks themselves but rather the social phenomena shaping their interpretation that present challenges to effective adaptation, the dissertation empowers public sector organizations and reinstates agency within them (Kaplan, 2008; Tierney, 2014).

Moreover, by outlining processes, mechanisms, and elements conducive to an improved interpretation of risks, enhanced decision-making, and fastened action-taking, the dissertation provides public managers with a set of tools they could use to advance agencies' management of the challenges faced. This will enable a more systematic approach to adaptation and reduces organizational over-reliance on ad-hoc procedures (Zhang & Welch, 2022).

CHAPTER 2

THE DATA COLLECTION STAGE

Abstract

Organizational risk perceptions are important triggers of organizational responses and motivate adaptive strategies. Drawing on information processing theory (IPT), this study examines how various sources of information, aimed at addressing the ambiguity and uncertainty surrounding extreme weather phenomena, shape public agencies' risk perceptions. I develop hypotheses particularly looking at the role played by outsourcing decisions and reliance on scientific and professional sources of information, testing them by integrating administrative data with a survey of public managers employed across the 300 largest transit agencies in the US. Results show that reliance on scientific and professional sources of information is positively associated with perceived risk of extreme weather events. The effect of contracting on risk perceptions depends on agencies' outsourcing strategies.

Introduction

Extreme weather events are among the most prominent hazards posing the greatest risks to public organizations. Extreme weather events are climate occurrences that are more severe, inconsistent, and damaging than what has been observed historically and represent a major source of alarm, due to their inherent *uncertainty* and *ambiguity* (Daft & Lengel, 1986; Daft & Weick, 1984; IPCC, 2012). Uncertainty exists about "when" these events will occur, "where" they will hit, and "how" severe and frequent they will be (Markolf et al., 2019; Zhang & Welch, 2022). Ambiguity stems from the

lack of understanding about the direct and indirect consequences that these events will have on social and institutional systems (Markolf et al., 2019).

To address uncertainty and ambiguity and support agency sensemaking of the environment, organizations put in place information processing strategies such as contracting and reliance on scientific and professional information (Daft & Lengel, 1986; Galbraith, 1974; Jennings & Hall, 2012; Karaba et al., 2022). However, the effectiveness of these solutions for improving agency understanding of extreme weather events and the related risks is unclear (Phillips et al., 2021). In response, this research integrates information processing theory (IPT) and contracting governance scholarship to answer the question: *How do scientific information and contracting influence public transit agency perceptions of extreme weather risk*?

I focus on organizational risk perceptions because these subjective judgments about organizational exposure to hazards can heighten perceived salience and increase the likelihood that an agency will take action to respond or act to prevent such hazards (Bundy et al., 2013; Renn, 1998). Moreover, risk perceptions are key determinants of adaptation to recurrent extreme weather events and may counterbalance path-dependent cultures and routines that bring public agencies to underinvest in corrective measures (Miao et al., 2018; Nowell & Stutler, 2020; Zhang, 2022). By examining the extent to which different sources of information can offset organizational inertia I not only contribute to our theoretical understanding of agency decision-making processes but also inform organizations about how to improve hazard response.

In this study, I apply IPT and contractual governance theory to examine the role of contracting and professional and scientific information in influencing agency risk perceptions. IPT allows me to examine how organizations make sense of ambiguous, and uncertain environments and perceive the risks that stem from them. It also advances knowledge about agency interpretative processes as they deal with environmental instability, and uncertainty (Aben et al. 2021; Lumineau 2017, Tushman and Nadler 1978; Daft and Lengel 1986). Contract governance scholarship anticipates that the effect of vendors on risk perceptions is contingent on three elements of agency outsourcing strategy: amount of activities contracted out, number of contractors, and type of activity outsourced. Additionally, I expect that scientific and professional sources of information shape agency understanding of the environment and reduce both ambiguity and uncertainty about extreme weather events.

I test these hypotheses estimating a mediation model. Data come from three main sources; a national survey administered to managers working in the 300 largest US transit agencies, the National Transit Database (NTD), and the Federal Emergency Management Agency (FEMA) dataset on federally declared disasters.

The study contributes to the literature in three ways. First, I extend the application of IPT to US public transit agencies dealing with extreme weather events, illustrating how different sources of information may shape agency perceptions of risk. Second, I disentangle the effect of contractual elements on risk perceptions showing that their impacts depend on how they shape environmental uncertainty and ambiguity. Last, I advance the knowledge around the relationship between sensemaking, information

transformation, and risk perceptions, responding to calls for theoretically informed studies on risk perceptions and management in the public context (Bullock et al., 2019). The study also provides information to agencies that want to reduce their reliance on path-dependent decision-making approaches and warns them against the underestimation of extreme weather event risks that can result from contracting strategies.

In the next section, I present some additional detail on transit agencies outsourcing strategies. I then turn to my theoretical framework and hypotheses development, data and methods, results, and conclusions outlining contributions to scholarship and implications for practice.

Focal Organizations: Public Transit Agencies

A key element that makes transit agencies a suitable context for this study is their increasing reliance on contractors. Contractors have historically played a key role in US transit agencies' operations, however, their prominence sharply increased starting from the ‘80s, when both liberals and conservatives appealed to voters by claiming that privatization and contracting would have improved transit agencies’ efficiency while reducing the governmental size (Zullo, 2008). This emphasis on productivity combined with limited funding brought transit agencies to increasingly rely on non-governmental actors to provide public goods and services (APTA, 2021; Zullo, 2008). From 2015 to 2019, the percentage of revenue hours public transit agencies have contracted out steadily increased for all the transit modes (APTA, 2021), and from 1994 to 2019, the share of transit agencies’ expenditures on private contractors grew by 18.8%, rising from 48% to 57% (APTA, 2021).

In addition to a growing reliance on contracting, commonalities among US public transportation agencies also regard the governance mechanisms organizations have in place, which are mostly competitive, transactional, and aimed at monitoring vendors (FTA 2021; GAO 2013). Conversely, variation among transit agencies exists regarding the contracting strategies organizations put in place with regard to the share of activities outsourced, the type of services hollowed out, and the number of vendors employed. Taken together, these factors make transit agencies an excellent focus for developing a generalizable understanding of the processes through which they interpret the environment and for understanding agency-level weather-related risk perceptions.

Integrating risk perception literature and the information processing theory

Risk perceptions are subjective judgments on organizations' exposure to an event as well as on its characteristics severity and consequences (Renn, 1998). Since organizational perception of risk results from agency-level interpretative processes (Weick & Sutcliffe, 2006), I study this phenomenon by building on the information processing theory. Integrating IPT with risk scholarship provides a fruitful theoretical contribution to public management research, as it allows for the examination of public sector organizations as key units of analysis.

As Gould (2021) highlights, there is a recognized need for more work on organizational risk perceptions. Risk management at the organizational level entails more than individual perceptions and technical assessments, hence, it must be studied by examining how organizational assumptions, logics, and norms influence agencies'

behaviors (Gould, 2021). In other words, although examining managers' interpretative processes can be useful to explain how agencies respond to environmental uncertainties and ambiguities, focusing exclusively on individuals – as done by extant public management scholarship (e.g., Roberts and Wernstedt 2019; Tangsgaard 2021) – is not sufficient to explain how agencies prepare for extreme phenomena and understand risks (Daft & Lengel, 1986; Gephart et al., 2009; Gould, 2021; Ungson et al., 1981).

While both managers and organizations receive and interpret information from the environment, the process through which agencies develop perceptions of risks is more complex and involves a greater amount of tasks (Daft & Lengel, 1986; Ungson et al., 1981). Different than the individual interpretative process, the organizational process entails discussions, debates, and coalition formation as managers need to converge on a similar interpretation of the environment and overcome disagreement and conflict (Daft & Lengel, 1986; Ungson et al., 1981). Focusing on the organization level also allows the integration of organization-level information processing theory to inform and advance knowledge on risk management in public agencies.

First introduced by Galbraith (1974) to illustrate why organizations process information, IPT has been expanded and adapted to explain organizational interpretative mechanisms (Daft & Lengel, 1986; Tushman & Nadler, 1978). The theory postulates that organizations are open systems that have interdependences with the environment in which they operate (Tushman & Nadler, 1978). These interdependences are a source of information asymmetry, as they require organizations to collect, process, and understand a great amount of information to achieve satisfactory performance (Daft & Lengel, 1986).

Consequently, organizations can adopt strategies either to minimize the amount of information they need to interpret or to increase their capacity to process them (Galbraith, 1974). The choice of the strategies to implement depends on the uncertainty and the ambiguity that characterize the environment in which organizations operate (Daft & Lengel, 1986).

Agencies dealing with uncertain environments need to collect more information and develop formal and standardized information systems that provide data to inform decisions (Daft & Lengel, 1986). Ambiguous environments require organizations to develop solutions that enable clarification, debates, and feedback (Daft & Lengel, 1986). According to the IPT, environments characterized by high levels of ambiguity and uncertainty, where sudden changes occur – like extreme weather events – require agencies to rely on special studies like scientific and technical reports, or to engage external actors (Daft & Lengel, 1986; Jennings & Hall, 2012). Although both of these strategies facilitate the exchange of subjective information and objective data, reducing uncertainty and ambiguity, the extent to which these solutions shape agency information processing capacity is unclear (Daft & Lengel, 1986; Yu et al., 2019). Hence, next section builds on the information processing theory to develop some hypotheses on how the strategies agencies use to overcome ambiguity and uncertainty impact the ability of organizations to perceive risk.

Information and risk perception

To reduce both *uncertainty* and *ambiguity*, IPT recommends greater reliance on professional and scientific sources of information (Daft & Lengel, 1986). Using academic

studies, professional reports, and technical best practices (i.e., scientific and professional sources of information) can increase agencies understanding of the environment and inform accurate decision-making processes through a systematic and rigorous process of data collection and analysis that would clarify the ambiguity underlying the phenomena under investigation while providing a detailed picture of causes and effects (Daft & Lengel, 1986). Scientific and professional sources of information also shape organizational perceptions of extreme weather events impacting analytical and experiential judgments (Slovic et al., 2004). Analytical judgments consist of objective appraisals of the risks faced, are reason-oriented, and based on sound theories. Experiential judgments are holistic, based on instinct and affect, and influenced by positive and negative images associated with an event (Slovic et al., 2004). The more negative an image, the greater the risk perceived (Finucane et al. 2000; Nisbet 2009). Hence, by providing richer and clearer data that serve as a basis to make objective risk assessments and conveying images that influence experiential judgments, scientific information shapes agencies' perceptions of risks (Slovic et al., 2004).

In the transit context, the complexity and sophistication of mass mobility infrastructures prevent agencies from being fully aware of the damages which could stem from extreme weather events (Perrow, 1994). Moreover, the interdependencies characterizing transit infrastructures can also mean that small localized breakdowns have the potential to cause unforeseen system-wide ripples resulting in humanitarian and managerial disasters (Markolf et al., 2019; Perrow, 1994). For this reason, organizations that use scientific and professional information (i.e., that rely on scientific information) as

inputs to inform decisions on how to prepare for extreme weather events may be more aware of their limits and of all the mechanisms through which extreme phenomena may disrupt them. In turn, organizations' analytical judgments of the damages caused by climate change will become more precise and increase perceptions of the gravity of the risks (Markolf et al., 2019). A more accurate perception of risks would also counter the agency tendency to underestimate the impacts of extreme weather events, ultimately increasing organizational perceptions of risks (Nowell & Stutler, 2020; Zhang, 2022). Since academic and professional reports often emphasize the dramatic and catastrophic elements characterizing climate change (Nisbet 2009), I expect these negative images to influence experiential judgments, ultimately increasing risk perceptions (Finucane et al., 2000; Wachinger et al., 2013).

Hypothesis 1: Greater reliance on scientific and professional sources of information is associated with higher perceived risk of extreme weather events.

Contracting and risk perception

IPT and contracting

A second element that IPT suggests can reduce information asymmetry is through "direct contacts" (Daft & Lengel, 1986). Although seminal works conceptualize direct contacts as organizational internal communication, recent literature on inter-organizational relations expands this concept to include also communications with contractors (Aben et al., 2021; Daft & Lengel, 1986). In detail, this scholarship suggests that public and private organizations have divergent goals and operate in different contexts, thus, they also have information systems that differ in their designs,

implementations, and outputs (Aben et al., 2021; Bozeman & Bretschneider, 1986; Doberstein, 2016). Given the differences between public and private information systems, some literature contends that divergences are irreconcilable and that contracting is detrimental to public performance as it increases complexity, impairing agencies' capacity of making sense of the environment (Comfort, 2007; Tushman & Nadler, 1978). Others, instead, argue that the impact contracting has on public agencies' information processing systems depends on three main elements: organizational goals, governance mechanisms, and complexity of the activity outsourced (Cao & Lumineau, 2015; Hartmann et al., 2014; Roehrich et al., 2020).

The goals public agencies want to achieve when entering into an agreement with private actors are the first contracting element that can influence organization sensemaking skills. Goals usually depend on stakeholder-relevant values like equity or efficiency and influence how public agencies form relationships with vendors (Brown et al., 2006). Some public sector organizations outsource their tasks to minimize costs, others do so to create social value (Caldwell et al., 2017). Agencies interested in cost savings control their contractors to ensure they are not behaving opportunistically (Brown & Potoski, 2005). However, implementing control mechanisms lowers trust and motivates contractors to exploit ambiguities to appropriate value through rents, preventing information transfers between the parties (Cao & Lumineau, 2015; Lumineau, 2017; Roehrich et al., 2020; Roehrich & Lewis, 2014). Conversely, when organizations want to create social value, coordination mechanisms are preferred to maximize the benefits that can stem from the buyer-supplier relationship (Caldwell et al., 2017; Quélin

et al., 2017). Coordination nurtures trust between the parties, increasing the willingness to develop shared solutions and a common understanding of the environment (Lumineau, 2017; Roehrich et al., 2020). For example, research has shown that when agencies collaboratively develop contracts they experience reductions in information asymmetries (Karaba et al., 2022). In the US public transit sector, most of the agencies indicate cost reduction and efficiency as the primary reasons considered when deciding to hollow out their activities and report having specific units in charge of oversight and control vendors (GAO, 2013).

The governance mechanism is the second contracting element that influences agency information processing capacity. Agencies can establish either transactional or relational mechanisms of governance (Aben et al., 2021). Transactional mechanisms of governance entail formal legally enforceable written contracts detailing the obligations and the responsibilities of the actors involved in the transaction. These provisions specify the control and the coordination tools parties put in place to ensure that the contract is fulfilled (Aben et al., 2021). Relational mechanisms of governance, instead, require the development of trusted relationships that motivate agencies to collaborate to reduce environmental uncertainties. These mechanisms address information asymmetry through the development of collaboration and expectation of proactive sharing of information, which result in a joint effort to gather, transform, and interpret environmental inputs, ultimately increasing agency information processing capacity (Aben et al., 2021; Roehrich & Lewis, 2014). It is important to note that a vast majority (94.3%) of transit agencies award contracts via competitive bidding, while noncompetitive (relational)

mechanisms like sole sourcing and contract extensions are used only by a minority of those surveyed (GAO 2013).

Finally, the complexity of the activity outsourced influences agency information processing capacity. Outsourcing complex activities usually fosters the development of complex transactional mechanisms of governance that emphasize control rather than coordination (Roehrich & Lewis, 2014). However, recent studies show that elaborate contracts aimed at controlling vendors often backfire as they are intrinsically incomplete and rigid, and for this reason, are unable to prevent contractors from behaving opportunistically (Brown & Potoski, 2005; Cao & Lumineau, 2015; Hart et al., 1997; Roehrich & Lewis, 2014). As a consequence, research suggests that a more effective approach to increase agency information processing capacity would use complementary transactional and relational governance mechanisms to promote trust, information sharing, joint sensemaking activities, and flexibility, without losing control and legal enforceability (Roehrich & Lewis, 2014).

Transit contracting in the US

US Transit agencies employ a variety of outsourcing strategies that have implications for their ability to process information. For example, agencies vary to the extent that they outsource their activities and operations to external actors. Some agencies perform all their tasks in-house, while others rely entirely on contractors.

Agencies that contract out some or all their activities also vary in the types of activities they outsource. Some agencies mostly outsource complex activities, others prefer to hollow out routine, simple tasks. Transit agencies outsource four types of

activities: facility maintenance, vehicle maintenance, general administration, and vehicle operations. Since the facility and vehicle maintenance functions include routine tasks as they entail activities like maintenance, clerical support, fare collection, cleaning, and fueling they can be considered "simple" services (Brown et al., 2018). The vehicle operations function, instead, entails "complex" activities as it consists of non-routine, knowledge-intense, difficult to monitor tasks such as scheduling of transportation operations, dispatching and supervising, and system security (FTA, 2020). Last, the "general administration" function entails both simple (e.g., accounting) and complex activities (e.g., purchasing) (FTA, 2020).

Cross-agency variation exists also with regard to the number of contractors agencies employ. Some agencies outsource their tasks to a single actor, others have a provider for each of the activities they outsource, yet still others choose to outsource the same activity to multiple providers. The decision on the number of contractors to employ varies depending on the complexity of the task outsourced. Generally speaking, the greater the complexity of a task, the lower the number of contractors that have the technical skills required to successfully provide it (Brown et al., 2018; Roehrich et al., 2020).

The following sections hypothesize and describe how each of the three elements distinguishing agency contracting strategies (i.e., amount of activities contracted out, types of activities contracted out, number of contractors employed) may influence their information processing capacity, impacting their capacity of making sense of the threats stemming from extreme weather events.

Amount of activities contracted out

The emphasis US transit agencies place on competitive bidding, cost reduction, control, and enactment of transactional governance mechanisms may negatively impact their sensemaking skills. Transactional governance mechanisms focused on controlling vendors increase opportunistic behaviors, reduce trust, and limit the amount of information shared between the parties to work-related interactions (Cao & Lumineau, 2015; Hartmann et al., 2014; Roehrich et al., 2020). Hence, it is reasonable to expect that, in the US transit sector, contracting activities out would add information asymmetry rather than reduce it, ultimately increasing uncertainty (Provan & Skinner, 1989).

Outsourcing may not only lower agency certainty about the environment but it may also reduce its capacity to make sense of it. Specifically, literature suggests that hollowing out can also cause losses of administrative capacity, technical expertise, and induce "brain drain" phenomena (Gen & Kingsley, 2007). Moreover, contracting reduces organizational capabilities, preventing agencies from effectively pursue their goals (Domberger & Jensen, 1998). Hence, I expect that the thinned cognitive capacity and the lack of technical expertise and skills, which characterize contracting agencies can prevent them from fully understanding and evaluating extreme weather events' threats, increasing information ambiguity.

Based on the above, since US transit agencies that decide to contract out have to deal with a more uncertain and ambiguous environment, I hypothesize a negative relationship between the extent to which organizations contract out their activities and their perception of extreme weather event risks. Specifically, I expect that transit

contracting makes perceptions of extreme weather events risks less accurate, reinforcing agency underestimation of the hazards posed by extreme phenomena, ultimately lowering their perceptions of risks.

Hypothesis 2a: Higher contracting levels are associated with lower perceived risk of extreme weather events.

Types of activities contracted out

I hypothesize that contracting out complex activities reduces agency processing capacity, increasing both information ambiguity and uncertainty. Conversely, outsourcing simple tasks should not particularly affect agency processing capacity, and thus, it should also not impair agency ability to make sense of the environment and correctly interpret the risks posed by extreme weather events.

Agencies that contract out complex services are more subject to losses of technical expertise and thus less capable of fully understanding and assessing the threats deriving from extreme weather phenomena (Domberger & Jensen, 1998; Gen & Kingsley, 2007). Moreover, although literature on inter-organizational relationships argues that contracting agencies should integrate both transactional and relational mechanisms of governance and invest time and resources in developing trust among the parties, US public transit agencies do not follow this advice (Roehrich et al., 2020; Roehrich & Lewis, 2014). Transit agencies that outsource complex activities typically adopt transactional mechanisms of governance, invest in control activities, and usually have contracts that do not last long enough to develop trust among the parties (i.e., ~5 years) (GAO, 2013). These features prevent agencies from developing relationships that

foster joint understandings and solutions to problems. Moreover, these contracting strategies increase information asymmetry and impair organizational interpretative capacity, leading to less accurate understanding of extreme weather events, and resulting in lower perceptions of risk.

Conversely, the governance mechanism agencies decide to enforce to outsource simple tasks should not entail losses of information capacity as those activities are usually easy to replicate as they do not require specialized and tacit know-how (Brown et al., 2018). Hence, I expect that the direct relationship between contracting and risk perception is not significant when organizations contract out simple tasks.

Hypothesis 2b: Higher contracting levels of complex activities are associated with lower perceived risk of extreme weather events.

Hypothesis 2c: Higher contracting levels of simple activities are not associated with higher perceived risk of extreme weather events.

Number of contractors employed

I also expect that the number of vendors an agency employs influences organizational environmental sensemaking capacity and ability to form accurate perceptions of risks. From an IPT perspective, agencies that have multiple contractors receive inputs from each vendor, hence, those with more contractors have access to richer information. Although more information may reduce uncertainty, it may not be sufficient to improve agency information capacity, especially when organizations face an

environment characterized by ambiguous, unclear, and ill-structured elements, like extreme weather events (Aben et al., 2021; Daft & Lengel, 1986).

Agencies employing several contractors receive information influenced by vendors' values and perceptions. As a consequence, the different understandings vendors have of the environment increase information messiness and ambiguity (Daft & Lengel, 1986). Moreover, the divergent goals, values, and incentives that exist among these numerous actors create complexity, induce inertia, and inhibit responsiveness (Doberstein, 2016). Hence, as the number of contractors employed grows, the complexity of the organizational decision-making process increases, requiring organizations to make more decisions resulting in less time available for each, ultimately impairing agency capacity to make sense of the environment (Galbraith, 1974; Wildavsky, 1983).

Although employing numerous contractors could reduce uncertainty and increase ambiguity, I expect that the effect number of contractors has on agency perceptions of risk would be negative for two main reasons. First, agencies mostly have in place transactional governance mechanisms, a feature that reinforces rigidity among the parties and limits the information agencies receive from vendors, mitigating the reduction in uncertainty that could stem from the employment of numerous contractors (Hartmann et al., 2014; Karaba et al., 2022). Second, because agencies decide to contract out to transfer risks (Sanderson et al., 2018), a greater number of contractors will carry with it a strong belief of having strategically diversified threats, resulting in lower perceived risk.

Hypothesis 2d: Greater number of contractors are associated with lower perceived risk of extreme weather events.

Contracting and scientific and professional sources of information

The three dimensions of contracting also influence agency reliance on scientific and professional sources of information. To this extent, I expect that the more transit agencies contract out their activities, the less they will rely on scientific and professional sources of information for two reasons. First, US public transit agencies usually adopt transactional governance mechanisms and use their information systems and resources to monitor their vendors. Hence, organizations that contract out are not structured to collect scientific sources of information that could support their decision-making processes to prepare for extreme weather events (Provan & Skinner, 1989). Second, the loss of technical expertise and the thinned cognitive systems caused by contracting, result in a reduced awareness and adoption of scientific and professional sources of information to make sense of the environment (Comfort, 2007; Gen & Kingsley, 2007). This loss is especially relevant for agencies that outsource large amounts of complex tasks, due to the need for extensive information processing capacity to monitor vendors and hold them accountable (Brown et al., 2018). Hence, I hypothesize:

Hypothesis 3a: Higher contracting levels are associated with less reliance on scientific and professional sources of information.

Hypothesis 3b: Higher contracting levels of complex activities are associated with less reliance on scientific and professional sources of information.

Hypothesis 3c: Higher contracting levels of simple activities are not associated with less reliance on scientific and professional sources of information.

Finally, I expect greater numbers of vendors to be associated with lower reliance on scientific and professional sources of information. Employing many contractors increases the total amount of information agencies receive from the environment, as each vendor would share some information with the organization. This richness of information, combined with organizational bounded rationality, reduces agency reliance on alternative sources of information like professional reports or academic studies (Wildavsky, 1983). Additionally, the greater the number of vendors involved in organizational operations, the greater the likelihood that one or more of the contractors has competing interests, conflicting goals, preferences, and values. This heterogeneity, in turn, increases the likelihood of conflicts, leading to a greater reliance on political arguments and heuristics, rather than scientific rationales (Heikkila et al., 2020).

Hypothesis 3d: A greater number of contractors is associated with less reliance on scientific and professional sources of information.

Data and Measures

Data

To test my hypotheses, I draw on three main sources of data: a 2019 national survey of managers working in the largest US transit agencies, the National Transit Database (NTD) reporting transit agency expenses and contractual relationships, and the Federal Emergency Management Agency (FEMA) dataset. I also merged data from the American Community Survey (ACS) and the *New York Times*[3].

[3] https://www.nytimes.com/elections/2016/results/president

The primary source of data is a 2019 national survey on the largest US transit agencies administered by the Center for Science, Technology, and Environmental Policy Studies at Arizona State University. The Human Research Ethics committees at Arizona State University (Study #00003589), approved the questionnaire. The research team administered the survey to US fixed-route public agencies having annual fare revenues greater than one million dollars in 2013 and operating bus and rail transit services in metropolitan areas. The team removed "small systems" agencies[4], agencies that refused to take part to the survey, and unreachable organizations from the sample frame. For each of the remaining 292 organizations, we sent the survey to managers of five departments (i.e., operations, maintenance, service planning, strategic planning, and engineering). Since not all the agencies have the five departments and because we removed some ineligible cases (e.g. retired, no longer employed) from the sample frame, the adjusted sample consisted of 911 managers. The survey closed with 313 usable responses from 194 agencies, for a response rate of 34.4% calculated according to the Response Rate 2 (RR2) method specified by the American Association for Public Opinion Research. The survey asked respondents questions regarding organizational experiences with extreme weather events, perceptions about future risks, and strategies employed to address natural hazards.

In addition to the survey data, I integrated openly available data from NTD and FEMA. NTD provides information regarding the financial, operating, and asset conditions of the US transit systems as well as data on agency funding sources,

[4] https://www.transit.dot.gov/ntd/2013-small-systems-waiver-reporting

contracting activities, and vehicles and maintenance facilities. I matched survey and NTD data with the FEMA disaster declarations dataset. The FEMA dataset provides information on the geographic areas in which disasters have occurred as well as on the types of events experienced. I use data regarding disasters caused by extreme weather events between 2014 and 2018 (i.e., five years before the survey administration). To control for social, and political elements influencing agencies' perceptions of extreme weather events I also merged county-level data from the American Community Survey 5-years estimates and 2016 presidential election data from the New York Times. The ACS data provide information on the social elements of the county where agency operates, which influence demand for transit service. Electoral results are a proxy of transit agency stakeholder-relevant values like equity or efficiency and influence how public agencies form relationships with vendors and the level of service they provide.

Measurement

The estimated model includes a key dependent variable, risk perception, and four focal independent variables: reliance on scientific and professional sources of information, and three transit contracting variables. I also include multiple variables to control for organizational and environmental factors.

Dependent Variable

The key premise shared by both IPT and Daft and Weick (1984) is the notion that while individual and organizational perceptions and interpretations of the external environment are interconnected, they also exhibit distinct characteristics. Unlike individual perceptions, which are influenced by personal backgrounds, organizational

perceptions are shaped by complex social dynamics and remain independent of actors' backgrounds.

In line with this argument, I operationalized **organizational risk perception** by combining three items of the 2019 survey in an equally weighted index with a Cronbach's alpha of 0.82. Specifically, the survey asked respondents to indicate their agreement with the following statements: "My agency is increasingly concerned about the impact of extreme weather events on our transit infrastructure"; "Most people in my agency recognize that extreme weather events are becoming more frequent"; "My agency is increasingly concerned about the impact of extreme weather events on our transit operations" (Response categories: 5-point Likert scale 1 =strongly disagree to 5 = strongly agree). This measure is consistent with both IPT and existing risk literature, as it focuses on expected frequency and severity of extreme weather events at the organizational level (Daft & Lengel, 1986; Slovic, 1987).

To further validate the measure's alignment with IPT and Daft and Weick's premise, I compare it with measures of respondents' **individual risk perceptions.** First I assess the correlation between the two measures, then I examine the extent to which respondents' professional backgrounds influenced both variables through two separate ANOVA analyses, whose results are reported in Table 1 and Table 2.

The measure of individual risk perceptions comes from a question asking respondents to rate the risk level extreme weather events posed to their agencies (5-point Likert scale, 1 = very low risk, 5 = very high risk).

Consistent with IPT, the correlation analysis reveals a positive, moderately strong, and statistically significant association between the two variables ($r = 0.40$; $p < 0.01$). Additionally, unlike organizational perceptions, ANOVA results indicate that individual risk perceptions are significantly influenced by respondents' functional backgrounds. This suggests the existence of internally discrepant perceptions of extreme weather risks within agencies, a feature further explored in the second study of the dissertation, which examines how such differences are reconciled within the organization.

Given that the organizational risk perception measure aligns both theoretically and empirically with IPT, it appears suitable for testing the hypotheses of this study.

Table 1: ANOVA examining the influence of individuals' functional backgrounds on organizational risk perceptions

Variable: Organizational Risk Perception	***Sum Sq***	***Mean Sq***	***F-Value***	***p-value***
Area of Work	7.20	1.03	1.446	0.187

Table 2: ANOVA examining the influence of individuals' functional backgrounds on their risk perceptions

Variable: Individual Risk Perception	***Sum Sq***	***Mean Sq***	***F-Value***	***p-value***
Area of Work	15.48	2.21	2.80	0.0078

Independent Variables

I include four independent variables in my model: **reliance on scientific and professional sources of information, transit contracting, types of activities contracted out, and number of contractors.**

I measure **reliance on scientific and professional sources of information** as an index of responses to seven items asking to indicate the extent to which agencies rely on "Technical reports"; "Vulnerability assessment tools"; "Publications in academic journals"; "Publicly available data sets"; "Professional mailing lists or newsletters"; "Professional associations (e.g. APTA, TRB, AASHTO)"; and "Industry standards (e.g. engineering standards)" to increase their ability to manage the risks associated with extreme weather (Response categories: 5-point Likert scale: 1 = not at all to 5 = very high extent). The Cronbach's alpha for reliance on scientific and professional sources of information is 0.88.

With regards to the second independent variable, consistent with previous research, I measure **transit contracting** as the ratio of purchased Vehicle Revenue Hours (VRH) to the total VRH an agency incurred in 2018[5] (Zullo, 2008). The greater the ratio of purchased VRHs, the greater the proportion of activities an agency contracted out. The VRH data come from the NTD operating expenses file. VRH measures the hours that vehicles travel, or are scheduled to travel, while in revenue service. In other words, VRH measures the revenue-producing time during which vehicles can be used for transporting passengers (FTA, 2021). Using VRH to measure contracting has several benefits compared to using other financial measures. First, it allows to standardize and compare contracting costs across the US. States like California or New York have price levels much higher than the rest of the country, hence, comparing the expenses incurred by agencies located in those states to the ones of organizations operating in Mississippi or

[5] I have also tested the model measuring transit contracting as percentage of expenditures, obtaining consistent results

Kansas may be misleading (Zullo, 2008). Second, organizations operating in large cities like Phoenix or Los Angeles, experience traffic congestion that causes fuel and operations inefficiencies, which make transportation expenses higher and non-comparable with the ones incurred by agencies operating in rural areas (McCullough et al., 1998; Zullo, 2008). Third, emphasis on universal access in some transit systems can lead to higher service levels and greater costs compared to organizations that do not have the same priorities (McCullough et al., 1998).

Types of activities contracted out is measured as the extent to which agencies outsource complex activities (i.e., vehicle operations services) and simple tasks (i.e., facility and vehicle maintenance). I measure these variables by looking at the operating expenses file agencies need to submit to the FTA. For each of the four functions defined by the NTD (i.e., facility maintenance, vehicle maintenance, general administration, and vehicle operations), agencies are required to report the expenses incurred, specifying whether these expenses were directly operated or contracted out (i.e., purchased). For each function, I then computed the ratio of purchased expenses to the total expenses an agency reported in 2018.

Number of contractors is a count of the number of vendors each agency had business with in 2018. The data on contractual relationships were provided by the NTD.

Control Variables

The model includes several organizational, societal, and individual control variables that literature suggests could influence estimates.

At the organization level, I control for prior **experience of extreme weather events**, since this variable has been shown to impact risk perception (Wachinger et al., 2013; Zhang et al., 2018). I measure previous experiences of extreme weather events by looking at FEMA disaster declarations in the five years preceding the survey administration (i.e., 2014 – 2018). Since FEMA data specify the type of disaster a county has experienced, I consider declarations regarding the following types of emergencies: severe ice storm, severe storm, flood, hurricane, typhoon, tornado, snow, and coastal storm (NOAA, 2022). Moreover, following Zhang (2022) who shows hurricanes as the most salient events for organizations, I also include a dummy variable (i.e., **Hurricanes**), equal to 1 if the agency has experienced hurricanes in the five years preceding the survey administration, and zero otherwise.

I control for both the contractual length and the type of contracts agencies have in place, as literature suggests that both these elements influence the type of information vendors are willing to share with agencies and organizational information processing capacity (Aben et al., 2021; Cao & Lumineau, 2015). I computed **contract length** as the average duration of contracts that transit agencies had in place during the five years preceding the administration of the survey (i.e. 2018 – 2014). **Award mechanisms** is a binary variable equal zero if agencies awarded vendors only through competitively-bids, one otherwise. Data for both the contract variables come from the NTD open data.

To account for regional differences in extreme weather events and other factors, I control for the **geographic division** in which each agency is located by including four dummy variables: West, Midwest, Northeast, and, South (1 = yes). I also control for the

types of services each agency provides by including a set of three dummy variables in the model: bus, light rail, and heavy rail. Decisions to contract out and outsourcing effects on organizational complexity may also depend on agency size and complexity. For this reason, I include agency **Vehicle Revenue Hours** in 2018 (natural logarithm).

Since managers working in different functions may vary in the extent to which they experience and perceive extreme weather events, I include a set of eight individual-level dummy variables indicating the main **area of work**: operations, maintenance, engineering, service planning, strategic planning, emergency management, public relations, and asset management (1 = yes) (Wachinger et al., 2013). I also control for individual years of work experience, measuring the natural logarithm of the **number of years respondents have worked in the transportation sector**. More senior respondents may have greater experience with extreme weather events and have higher perceived risk because of it.

Reliance on scientific and professional sources of information per se does not ensure that information is properly processed. Literature suggests that educated individuals are more likely to understand scientific information (Case, 2007). Hence, I control for the **educational level** of the respondents. I include a set of three individual-level dummy variables indicating manager educational level: less than bachelor degree, bachelor degree, more than bachelor degree (1 = yes).

Politics play a key role in agency operations. Stakeholder-relevant values like equity or efficiency influence service levels, priorities, and strategies of public agencies, as organizational decision-making processes are influenced by both formal and informal

interactions existing between an agency and its community (Rainey, 2009). Moreover, since transit agency leadership is often appointed or elected, leaders' interpretations of extreme weather events will be influenced by the political environment in which they operate. Hence, public organizations in more politically liberal environments would more likely acknowledge climate change and perceive the challenges it poses as more pressing (Hotimsky et al., 2006). For this reason, I include in the model a variable (i.e., **Democrats**) measuring the percentage of democratic votes during the 2016 presidential elections in the counties in which agencies have their headquarters. I downloaded electoral data collected from the New York Times.

Finally, I control for **population density** (natural logarithm) and **commute time to work** (natural logarithm) as general characteristics of the geographical areas served by transit agencies. These two variables are proxies for the demand for transit services and may be positively related to contracting decisions (Ya Ni & Bretschneider, 2007). I download both these data from the ACS 5-year estimates portal.

Table 3 presents the descriptive statistics for the variables included in the study and their sources. Correlations among key variables are reported in Table 4.

Table 3: Summary Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Dependent Variable					
Organizational Risk Perception	299	1	5	3.37	0.85
Independent Variables					
Scientific and Professional Source of Info	303	1	5	2.11	0.76
Transit Contracting (2018)	313	0	1	0.35	0.38
Transit Contracting (2018) – Complex	313	0	1	0.32	0.39
Transit Contracting (2018) – Simple	313	0	1	0.30	0.41
# Contractors (2018)	313	0	30	2.12	3.39
Control Variables					
Extreme weather events experience (2014-2018)	313	0	10	1.53	1.69
Hurricanes	313	0	1	0.20	0.40
Contracts' length	313	0	5	3.33	2.06
Award mechanism	313	0	1	0.19	0.39
South	313	0	1	0.28	0.45
Northeast	313	0	1	0.13	0.33
Midwest	313	0	1	0.23	0.42
West	313	0	1	0.36	0.48
Bus	313	0	1	0.93	0.26
Heavy Rail	313	0	1	0.09	0.28
Light Rail	313	0	1	0.20	0.40
VRH (ln)	313	0	16.10	12.57	2.03
AoW: Operations	313	0	1	0.37	0.48
AoW: Maintenance	313	0	1	0.16	0.37
AoW: Engineering	313	0	1	0.04	0.21
AoW: Service Planning	313	0	1	0.14	0.34
AoW: Strategic Planning	313	0	1	0.15	0.36
AoW: Emergency Management	313	0	1	0.08	0.27
AoW: Public Relations	313	0	1	0.03	0.16
AoW: Asset Management	313	0	1	0.02	0.15
Experience (ln)	291	0.41	3.96	2.96	0.68
Less than bachelor	293	0	1	0.26	0.44
Bachelor	293	0	1	0.30	0.46
More than bachelor	293	0	1	0.44	0.50
Democrats 2016	313	0.31	0.96	0.60	0.14
Density (ln)	312	6.79	8.85	7.87	0.44
Commute Time (ln)	313	2.75	3.67	3.22	0.19

Table 4: Correlation matrix

#	Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	Organizational Risk Perception	1																				
2	Scientific Info	0.33*	1																			
3	Transit Contracting (2018)	-0.09	0.02	1																		
4	Complex Contracting (2018)	-0.10	0.00	0.98*	1																	
5	Simple Contracting (2018)	-0.09	0.00	0.96*	0.99*	1																
6	# Contractors (2018)	0.07	0.18*	0.17*	0.15*	0.11	1															
7	Extreme weather events experience (2014-2018)	0.25*	0.20*	0.17*	0.17*	0.18*	-0.09	1														
8	Award mechanism	0.04	0.16*	0.03	0.02	0.01	0.41*	-0.02	1													
9	South	0.24*	0.10	-0.05	-0.04	-0.05	-0.08	0.53*	-0.01	1												
10	Northeast	0.08	-0.05	0.09	0.07	0.09	0.00	-0.10	-0.01	-0.24*	1											
11	Midwest	-0.06	-0.06	-0.26*	-0.27*	-0.28*	0.15*	-0.36*	0.05	-0.34*	-0.21*	1										
12	West	-0.24*	0.00	0.22*	0.22*	0.22*	-0.06	-0.12*	-0.03	-0.47*	-0.29*	-0.41*	1									
13	Bus	-0.01	-0.08	-0.10	-0.12*	-0.13*	0.09	-0.02	-0.22*	0.06	-0.08	0.06	-0.06	1								
14	Heavy Rail	0.00	0.14*	0.04	0.05	0.07	0.06	0.01	0.26*	-0.04	0.05	-0.03	0.03	-0.49*	1							
15	Light Rail	0.04	0.09	-0.02	-0.02	-0.03	0.07	0.02	0.15*	0.03	-0.03	-0.11	0.08	-0.20*	0.18*	1						
16	Vehicle Revenue Hours (ln)	0.06	0.09	0.00	-0.03	-0.06	0.22*	-0.04	0.16*	0.05	-0.06	0.02	-0.03	-0.03	0.20*	0.18*	1					
17	Experience in Transit (ln)	0.11	0.06	-0.03	-0.04	-0.05	0.07	0.10	0.05	0.12*	-0.11	-0.09	0.05	-0.04	0.04	0.05	0.03	1				
18	Contracts' length	-0.03	0.09	0.48*	0.43*	0.38*	0.33*	0.03	0.27*	-0.05	0.01	-0.10	0.14*	-0.04	0.08	0.02	0.24*	-0.03	1			
19	Democrats 2016	0.05	0.14*	0.13*	0.10	0.10	0.11*	0.07	0.21*	-0.13*	-0.07	-0.13*	0.28*	-0.18*	0.27*	0.20*	0.30*	0.11	0.26*	1		
20	Density (ln)	-0.12*	0.07	0.21*	0.19*	0.20*	0.08	-0.16*	0.03	-0.33*	-0.11*	-0.24*	0.60*	-0.22*	0.17*	0.17*	0.20*	0.05	0.17*	0.51*	1	
21	Commute Time (ln)	0.02	0.09	0.30*	0.30*	0.30*	0.17*	0.10	0.09	-0.08	0.02	-0.35*	0.37*	-0.25*	0.18*	0.12*	0.17*	0.14*	0.21*	0.41*	0.52*	1

* Correlation is significant at the 0.05 level

Model and Results

To test my hypotheses, I estimate three OLS regressions using a single mediator. I include the control variables in all the paths and cluster standard errors by organizations since transit agencies are the units of analysis. The first model tests hypotheses 1, 2a, 2d, 3a, and 3d, and investigates the relationships linking the extent to which agencies contract out their tasks, the number of vendors an agency employs, organizational risk perception, and its reliance on scientific and professional sources of information. The second and third models predict whether the types of activities agencies contract out influence organization perceptions of risk. Specifically, the second model looks at the effect of outsourcing complex tasks (H2b, H3b), while the third one examines the consequences of contracting out simple activities (H2c, H3c).

In the structural model, 24 observations were removed because of missing values in the exogenous variable, resulting in a final dataset containing 289 observations. Tables 5 to 7, report the standardized estimates. Table 5 shows results related to the first model, and Table 6 and Table 7 present the estimates for the second and third models, respectively. I discuss findings related to each hypothesis and then discuss limitations and implications.

Table 5: Model estimations

	Reliance on Scientific Sources of Information		
Parameter	*Estimate*	*Std. Err.*	*z-value*
Transit Contracting (2018)	**-0.117***	0.071	-1.654
Number of Contractors (2018)	**0.235*****	0.087	2.692
Extreme weather events experience (2014 - 2018)	**0.222*****	0.084	2.635
Hurricanes	0.059	0.098	0.597
Contracts' length	0.026	0.071	0.361
Award mechanism	0.004	0.070	0.057
South	-0.002	0.093	-0.017
Northeast	-0.010	0.054	-0.190
Midwest	0.013	0.071	0.186
Bus	-0.027	0.067	-0.410
Heavy Rail	0.065	0.055	1.176
Light Rail	0.016	0.052	0.313
Vehicle Revenue Hours (ln)	-0.012	0.051	-0.235
Area of Work: Operations	-0.003	0.171	-0.016
Area of Work: Maintenance	-0.041	0.137	-0.299
Area of Work: Engineering	0.092	0.084	1.096
Area of Work: Service Planning	0.053	0.126	0.417
Area of Work: Strategic Planning	0.130	0.134	0.970
Area of Work: Safety/Emergency Management	0.063	0.107	0.588
Area of Work: Public Relations/Communication	0.008	0.062	0.130
Experience in Transit (ln)	-0.002	0.058	-0.040
Less than Bachelor	0.033	0.076	0.436
Bachelor	-0.053	0.065	-0.821
Democrats	0.066	0.068	0.975
Density (ln)	0.097	0.087	1.112
Commute Time (ln)	-0.010	0.078	-0.123
N	289		
R-Square	0.170		

** p<0.1, ** p<0.05, *** p<0.01, Reference Division: West; Reference Area of Work Asset Management*

	Organizational Risk Perception		
Parameter	*Estimate*	*Std. Err.*	*z-value*
Transit Contracting (2018)	**-0.127****	0.064	-1.984
Number of Contractors (2018)	0.054	0.052	1.046
Reliance on scientific information	**0.269*****	0.064	4.181
Extreme weather events experience (2014 - 2018)	**0.140****	0.065	2.139
Hurricanes	-0.004	0.096	-0.045
Contracts' length	-0.018	0.066	-0.274
Award mechanism	-0.042	0.058	-0.715
South	**0.215***	0.113	1.898
Northeast	**0.217*****	0.061	3.558
Midwest	0.091	0.087	1.040
Bus	-0.039	0.063	-0.620
Heavy Rail	-0.062	0.083	-0.749
Light Rail	0.013	0.056	0.232
Vehicle Revenue Hours (ln)	-0.016	0.041	-0.404
Area of Work: Operations	0.064	0.203	0.313
Area of Work: Maintenance	-0.032	0.163	-0.195
Area of Work: Engineering	0.040	0.099	0.410
Area of Work: Service Planning	0.049	0.149	0.328
Area of Work: Strategic Planning	0.106	0.167	0.632
Area of Work: Safety/Emergency Management	0.130	0.131	0.987
Area of Work: Public Relations/Communication	-0.053	0.079	-0.678
Experience in Transit (ln)	0.057	0.058	0.983
Less than Bachelor	0,113	0.075	1.509
Bachelor	0.009	0.062	0.154
Democrats	0.082	0.065	1.261
Density (ln)	-0.043	0.085	-0.507
Commute Time (ln)	0.073	0.074	0.984
N	289		
R-Square	0.261		

** p<0.1, ** p<0.05, *** p<0.01, Reference Division: West; Reference Area of Work Asset Management*

Table 6: Model estimations - Complex tasks

	Reliance on Scientific Sources of Information		
Parameter	*Estimate*	*Std. Err.*	*z-value*
Transit Contracting – Complex Tasks (2018)	**-0.123***	0.068	-1.805
Control Variables	YES		
N	289		
R-Square	0.171		

	Organizational Risk Perception		
Parameter	*Estimate*	*Std. Err.*	*z-value*
Transit Contracting – Complex Tasks (2018)	**-0.121****	0.061	-1.975
Control Variables	YES		
N	289		
R-Square	0.260		

Table 7: Model estimations - Simple tasks

	Reliance on Scientific Sources of Information		
Parameter	*Estimate*	*Std. Err.*	*z-value*
Transit Contracting – Simple Tasks (2018)	-0.108	0.067	-1.621
Control Variables	YES		
N	289		
R-Square	0.169		

	Organizational Risk Perception		
Parameter	*Estimate*	*Std. Err.*	*z-value*
Transit Contracting – Simple Tasks (2018)	-0.092	0.060	-1.529
Control Variables	YES		
N	289		
R-Square	0.256		

Results

Estimates reported in Table 5 support Hypothesis 1, which expects that greater reliance on scientific and professional sources of information is associated with higher levels of risk perceptions ($B = -0.127$; $p < 0.05$). In other words, the more agencies use scientific studies and professional reports to inform decisions on how to best prepare for extreme weather events, the greater their perception of risk.

Results also support Hypothesis 2a that expects contracting out to be positively associated with lower levels of perceived risk. A one standard deviation increase in the percentage of VRH that agencies contract out (approximately 38%) reduces perceived risk by 0.127 standard deviations ($p < 0.05$). I also find support for Hypothesis 3a which predicts transit contracting to be negatively associated with organizational reliance on scientific and professional sources of information ($B = -0.117$; $p < 0.1$).

The models do not support hypotheses 2d and 3d, which predict that agencies that employ more contractors would perceive less risk and would be less likely to use scientific and professional studies to inform decisions on extreme weather events. I find that a standard deviation increase in the number of contractors employed (approximately 4 contractors) is not related to a significant change in the level of perceived risk but is significantly associated with a greater reliance on scientific and professional sources of information ($B = 0.235$; $p < 0.01$).

The hypotheses linking the complexity of the contracted activity to organizational risk perception (2b, 2c) and reliance on scientific and professional sources of information (3b, 3c) are supported. Agencies that outsource more complex tasks show both higher

levels of perceived risk (B = -0.121; $p < 0.05$) and lower reliance on scientific and professional sources of information (B = -0.123l $p < 0.1$). Conversely, when agencies outsource simple tasks, neither their perceived risk nor their reliance on scientific and professional sources of information are significantly affected.

Discussion and Implications

In this study, I integrate information processing theory (IPT) with contracting scholarship to understand how different information processing strategies influence agency perception of the threats posed by extreme weather events. I extend the IPT application to public sector organizations dealing with extreme weather phenomena, finding support for most of my theoretical expectations about the role played by scientific and professional sources of information and outsourcing strategies in shaping agency sensemaking capacity.

Findings contribute to organizational interpretative theory showing that agency perception and assessment of extreme weather events depend on the solutions put in place to address their inherent uncertainty and ambiguity. In particular, I find support for what IPT predicts to be the role of scientific and professional information in shaping organizational interpretation of the environment. Using scientific information to guide public sector organization decisions on how to respond to extreme phenomena reduces both the uncertainty and ambiguity agencies face, countering potential political, administrative, and institutional elements that often prevent them from fully understanding the environment. This finding validates Galbraith's (1974) prediction that the information strategies agencies take can reduce environmental complexity. Agencies

that decide to rely on scientific sources of information not only invest resources to find up-to-date technical information but also develop the internal capacity to properly understand it, increasing their ability to navigate complex environments and to make sense of non-routine phenomena like extreme weather events (Galbraith, 1974).

Results on the role contracting plays in shaping agency understanding of the environment, align with previous studies suggesting that contracting changes agency organizational structures and influences organizational sensemaking processes (Karaba et al., 2022; Kinder & Burgoyne, 2013). Findings support the theoretical distinction existing between two aspects of information asymmetry (i.e., ambiguity and uncertainty) and how each of these elements influence transit agency understanding of the environment (Aben et al., 2021). This distinction may also explain the non-significant relationship linking the number of vendors employed and risk perception. On the one hand, working with numerous contractors provides agency with richer information (reducing uncertainty). On the other hand, as the number of vendors increases, there will be more confusion as each agent provides with a different interpretation of reality (increasing ambiguity). Consequently, the opposite directions of these two effects results in a largely null relationship between number of contractors and risk perception.

Findings on the role of relational governance mechanisms suggest that governance systems that focus on controlling and monitoring transactions may negatively affect the trust between transit agencies and their vendors. This aligns with the contracting and interpretative literatures and supports the conclusion that an accurate understanding of the environment stems from a knowledge co-production process, which

requires mechanisms that facilitate the exchange of subjective and objective information, entailing the convergence of different perceptions (Daft & Lengel, 1986).

Results also contribute to scholarship postulating the existence of different information systems characterizing public and private organizations (Bozeman & Bretschneider, 1986). Transit agencies that over-rely on contractors and use transactional mechanisms of governance suffer from divergent interests, impoverished cognitive systems, and thinned technical skills, three elements that reduce agency information processing capacity (Bozeman & Bretschneider, 1986; Comfort, 2007; Roehrich & Lewis, 2014). Moreover, findings show that outsourcing complex activities may especially be harmful unless agencies invest in the development of relational governance mechanisms, which could favor information sharing between the parties, minimizing both uncertainty and ambiguity (Aben et al., 2021; Karaba et al., 2022).

Taken together, these results expand Galbraith, Daft, and Lengel's expectations about the role lateral relations have in reducing information asymmetry. Specifically, I find that the effect of outsourcing on agency sensemaking capacities is contingent upon the contracting strategies it has in place. That is, results underscore the importance for managers and research to assess all the elements characterizing agency contracting strategies to fully understand their effects on organizational perceptions of risk.

An additional contribution of this research to sensemaking scholarship stems from the integration of IPT and organizational perceptions of extreme weather events to examine public organizations as risk receivers, and how they deal with threats of extreme phenomena (Bullock et al., 2019; Gould, 2021; Phillips et al., 2021). The geographic

dispersion of the agencies surveyed, the heterogeneity of the populations served, as well as the variation existing in terms of types of extreme phenomena experienced, suggest that these results may hold in a variety of public contexts. Future research should examine whether these results apply to other hazards (e.g., cyber-attacks) that have comparable levels of uncertainty and ambiguity.

The study has implications for both policy and practice. Procurement policies that encourage cost-minimization and transactional contracts may have unintended consequences. Outsourcing strategies exclusively aimed at achieving savings may cause losses of expertise, hinder agency understanding of the environment, and impoverish organizational adaptation to extreme phenomena, potentially causing humanitarian and infrastructural disasters. Although achieving efficiency is important, it is also critical to develop relational governance mechanisms to ensure preparedness for extreme phenomena and safeguard user safety, especially when hollowing out complex tasks.

From an organizational perspective, consistent with Galbraith (1974), findings suggest that agencies that want to better understand the environment should either increase their capacity to process information or minimize the need for information processing. Increasing agency reliance on scientific and professional sources of information improves capacity for making sense of the environment. Joining professional associations, adopting state-of-the-art technology and standards, and making decisions based on rigorous scientific assessments and studies reduce extreme weather event uncertainty and ambiguity, thereby improving agency assessment of extreme weather hazards. Conversely, contracting out simple tasks to multiple vendors may minimize the

need for information processing as this strategy would allow the organization to deal with richer and more standardized information, hedging against potential loss of technical expertise.

Although my estimates provide preliminary insights on how contracting and reliance on scientific and professional sources of information influence public agency perceptions of extreme weather event risks, I also acknowledge some limitations of this study. First, there is potential for endogeneity in the models. In contrast to my expectations, it may be the case that higher perceived risk causes organizations to rely more on scientific sources of information. However, theories on risk perception suggest that the direction of the relationship is the one I depict (Slovic et al., 2004; Wachinger et al., 2013). Future research could further explore this relationship by testing it using longitudinal data or by employing an instrumental variable to alleviate concerns about endogeneity (Angrist & Pischke, 2009).

Second, because I measure both agency risk perceptions and reliance on scientific sources of information using survey data, common source bias and social desirability bias may have affected results. Nevertheless, the survey was designed to minimize these concerns. For example, I temporally and psychologically separated the measurements included in the models by placing them in two different sections of the survey (Podsakoff et al., 2003). Moreover, I used previously tested measures, and ensured participant anonymity, following the best practices that literature suggests should address common source and social desirability biases (Podsakoff et al., 2003).

A third limitation of the study stems from the fact that the models do not consider task differentiation between vendors. In other words, I do not know whether multiple contractors are doing the same activity or if there are many contractors doing different things. Although I acknowledge that this is an important element of agency contracting strategy that may influence organizational information processing capacity, NTD does not provide detailed information on the activities each agency contracts out to its vendors. Last, the adoption of cross-sectional survey data does not allow to infer causality (Angrist & Pischke, 2009). As a result, I am careful to posit association in the hypotheses, but employ literature-based argument to establish theoretically sound causal rationales.

Conclusion

The National Oceanic and Atmospheric Administration (NOAA) estimated that in 2021 extreme weather events costed US taxpayers 145 billion dollars in damages and reported that three of the five costliest years on record for extreme weather damages took place in the five years prior to the report (NOAA, 2020). Future scenarios are even more catastrophic as extreme phenomena are becoming more frequent and severe. Despite their role of "ultimate bearer of societal risks", public agencies are not always prepared to face the challenges posed by climate change as political, administrative, and institutional elements prevent them from fully understanding the risks these events pose. This study examines how scientific sources of information and contract elements can influence the "uncertainty" and the "ambiguity" characterizing extreme weather events, ultimately shaping public agency risk perceptions. Findings show that professional and scientific sources of information improve agency understanding of the environment and increase

agency perceptions of risk. The effect of contracting on organizational perceived risk is more nuanced and depends on the strategy and the governance mechanisms agencies put in place. Although results have implications for both theory and practice, future studies should investigate how other elements not considered here but characterizing IPT (e.g., formal processes) (Daft and Lengel,1986) might reduce environmental ambiguity and uncertainty affecting organizational risk perception.

CHAPTER 3

THE INTERPRETATION STAGE

Abstract

Organizational interpretations of the external environment are conceptual schemas shared by organizational actors and play key roles in organizations' functioning. Interpretations serve both retrospective purposes, aiding in making sense of past events, and prospective aims, guiding future actions. While research extensively studies retrospective uses of interpretations, less is known about the formation of shared meanings around current and impending events. Nonetheless, a thorough understanding of how these processes unfold is critical to effectively adapt to future threats. Drawing from in-depth semi-structured interviews with public transit managers, this study contributes to the broader organizational interpretative scholarship by describing the processes through which shared interpretations are developed among organizational actors when planning for extreme weather phenomena. I identify three mechanisms that foster the development of intersubjective interpretations: conversation, suppression, and shared experiences. I describe the main elements characterizing each of the mechanisms, discussing their implications for both research and practice.

Introduction

Organizational interpretations are conceptual schemas shared by organizational actors that play a key role in organizations' functioning (Daft & Weick, 1984). Interpretations enable a comprehensive assessment of the organizational context and facilitate the development of solutions to address issues (Cornelissen & Werner, 2014;

Daft & Weick, 1984). Interpretations also guide actions in response to challenges and support the sensemaking process by imposing order to past experiences (Daft & Weick, 1984; Maitlis & Christianson, 2014).

While organizational interpretations are critical for fostering sense-making and adaptability, they are often difficult to understand and challenging to describe (Gavetti & Warglien, 2015; Weick, 1969). This complexity stems from the fact that organizational interpretations involve interactions among members and result from social processes operating across various levels – from individual to organizational (Daft & Lengel, 1986; Daft & Weick, 1984; Gavetti & Warglien, 2015). Consequently, extant literature mostly examines how organizations retrospectively interpret past crises and jolts as these events are usually well-documented, and easier to reconstruct (Gephart et al., 2010; Maitlis & Christianson, 2014; Sandberg & Tsoukas, 2015). Less research, instead, examines the unfolding of future-oriented interpretations.

This gap is particularly problematic in the field of risk management. Poor understanding of how agencies make sense of current and future threats leads to interpretative and adaptive processes guided by individual judgments and experiences, rather than by theory (Berkhout, 2012; Gould, 2021). This, in turn, can lead to ineffective decision-making, increased exposure to risks, and a failure to anticipate and adapt to potential crises (Tierney, 2014). Hence, this research addresses the extant knowledge gap examining how public agencies interpret their operational domain, focusing on the internal mechanisms through which they collectively assign meanings to the external environment. Specifically, it aims to address the following research question: *How do*

public agencies cultivate a shared interpretation of the risks posed by extreme weather events?

Drawing on qualitative data collected through in-depth semi-structured interviews with US public managers in four different transit agencies, the study contributes to the extant scholarship and practice. It extends interpretative scholarship addressing the "bias of incidentalism" characterizing most of the extant scholarship (Sandberg & Tsoukas, 2015; van Eeten et al., 2010). This bias leads research to focus on interpretative processes associated with specific or exceptional events, viewing risks and challenges as isolated incidents and preventing a systematic approach to manage them (Stark, 2014; Zhang & Welch, 2022). Conversely, by examining the interpretation of broad categories of risks (i.e., extreme weather), and identifying the social mechanisms through which agencies can develop shared interpretations of the threats faced, this study empowers public agencies as it provide them with the knowledge of the tools that could ensure a more holistic approach to decision-making around the undertaking of adaptive actions, ultimately reducing organizational over-reliance on ad-hoc procedures (Zhang & Welch, 2022).

The study also shows how the roles, and the resources of decision-makers shape organizational interpretative process. While research recognizes that meanings in organizations are often contested because multiple interpretations of the external environment exist, few studies examine how organizations deal with these heterogenous perceptions. Yet, if not addressed, cognitive discrepancies can create political struggles, which prevent organizations from effectively make a decision and adapt to the challenges

posed by their operational contexts (Kaplan, 2008; Sandberg & Tsoukas, 2015). As a result, by examining the role of power and politics within the interpretative processes, this research equips organizations with tools to navigate cognitive discrepancies and achieve effective decision-making.

As further discussed in the following sections, I focus on public agencies dealing with extreme weather events since the inherent uncertainty and ambiguity of these phenomena, combined with their increasing severity and frequency, require the development of shared future-oriented interpretations to inform organizational adaptation (Valdivieso et al., 2021; Weick, 1993). Moreover, within public agencies, the presence of multiple and conflicting goals, along with the influence of political dynamics, often results in internally discrepant interpretations of the risks associated with extreme weather events (Linde, 2020). Thus, by delving into their interpretative dynamics, this research seeks to contribute to a deeper understanding of how public agencies formulate collective interpretations of the risks posed by extreme weather events, facilitating more effective adaptive responses.

The study is structured as follows. First, I define organizational interpretation. I then review the extant scholarship on this construct, discussing what it suggests for public agencies dealing with extreme weather. I then present to the data collection and analysis. I conclude discussing findings, limitations, and the implications for theory and practice.

Defining Organizational Interpretation

Interest around interpretation[6] traces back to classic organizational theorists who regarded it as a key element influencing organizational lives. For example, March (1980), contends that organizations exist on two levels: the level of action, and the level of interpretation. Action refers to all the activities actors put in place to cope with the context in which they operate, interpretation, instead, entails the intellectual processes which allow them to understand it. Similarly, Weick (1995) postulates that interpretations are fundamental elements which, together with organizational experiences, contribute to determine how organizations understand the world.

Despite the widespread recognition of interpretations as key tools to understand the context in which organizations operate, there are divergent views on the processes that produce organizational interpretations, their components, and the ways in which they unfold. Consequently, various approaches to study them have emerged (Daft & Weick, 1984). In particular, research on organizational interpretation can be categorized as belonging to two main streams of inquiry: intellectualism, and Wittgensteinian (Tsoukas, 2005).

According to intellectualism, organizational interpretations are the result of processes that turn experiences into conceptual orders, which closely reflects the external world (Tsoukas, 2005). Intellectualists, in other words, contend that organizations are like computers, which by running some programs can transform information coming from the

[6] To avoid confusion between individual interpretations and the organizational interpretation process, I explicitly mention "individual interpretation" when addressing personal perspectives.

external environment into models that approximate it (Tsoukas, 2005). Hence, processes of organizational interpretation are conceptualized as involving linear transformative processes whose outcomes are almost perfect representations of reality, and which are used to inform decisions and determine actions. Members of the Carnegie school[7] particularly adopt this stream of inquiry.

The Wittgensteinian perspective, instead, contends that organizational interpretations are the result of discursive practices, hence they do not entail an exact representation of the world, rather, an intersubjective constructed one (Tsoukas, 2005). In other words, Wittgensteinian studies recognize interpretations as inherently social phenomena influenced by interpreters' experiences, values, and discussions. Such interpretations, nonetheless, are retrospective rather than being future oriented (Gephart et al., 2010). Consequently, they result from actions rather than driving them (Brown et al., 2008). To this extent, sensemaking theory suggests that organizational interpretation involves discussions and sharing around members' perceptions of their past experiences (Maitlis & Christianson, 2014). These discussions then serve to develop a more complete and narratively organized sense of the contexts in which they have operated.

In spite of the ontological differences existing between the intellectualistic and the Wittgensteinian perspectives, research contends that these approaches can complement each other (Coraiola & Murcia, 2020). For instance, Coraiola and Murcia (2020) suggest that these two approaches share some elements which, if exploited, could provide some

[7] The Carnegie School refers to a group of organizational theorists, including Herbert A. Simon, James G. March, and Richard Cyert, among others, who have made significant contributions to understanding organizations as adaptive systems (Williamson, 1981)

fruitful avenues for theory-building. To this extent, this study, following intellectualists, acknowledges that interpretations serve and support decision-making processes. Conversely, it aligns with Wittgensteinian scholarship in defining organizational interpretations as a socially constructed phenomenon influenced by the individual, organizational, and discursive elements in which they are embedded. Hence, drawing on both these streams of inquiry, similarly to Daft and Weick (1984, p. 286) I define organizational interpretations, as "*processes that antecede and inform organizational action by translating events and developing shared understanding and conceptual schemes among organizational members"*.

Building upon this definition, next section reviews literature on organizational interpretations to understand its implications for public agencies aiming to integrate discrepant interpretations of the risks posed by extreme weather events. The review also informed the development of the initial protocol for the interviews and provided an initial set of codes through which I analyzed them.

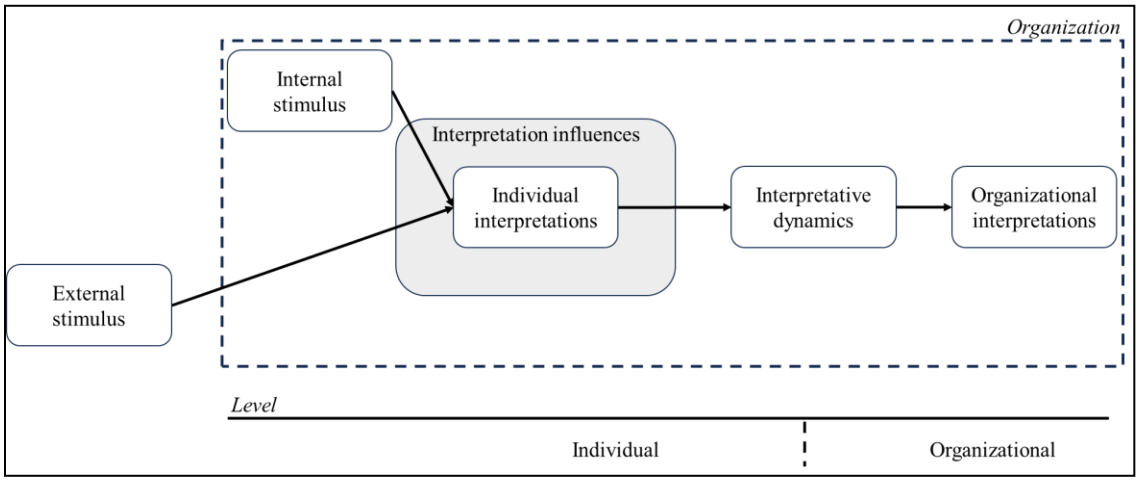
Drawing on literature reviews to inform qualitative research is advisable as they can support the formulation of questions for initial interviews and stimulate questions during the analytic process, helping researchers in embedding their study in larger traditions of inquiry (Corbin & Strauss, 2008; Marshall & Rossman, 2016). Finally, a literature review enhances the reliability of the research by bringing forth underlying assumptions, and displaying the values and the interpretations integral to the researcher's perspective (Marshall & Rossman, 2016).

Organizational interpretative process

Having defined what I mean by organizational interpretation in this section, I contextualize this study within previous scholarship, examining what literature suggests about the interpretative process of agencies aiming to develop intersubjective meanings of the risks posed by extreme weather events. I present each element of the process, describing more in detail its main characteristics and dynamics. I then conclude by identifying existing gaps in the literature and delineating how this study addresses them.

Figure 2 illustrates the organizational interpretative process derived from the review. The process unfolds from the individual to the organizational level, transitioning as it progresses. It starts with individual members making sense of a stimulus (e.g., a threat, uncertain information, a crisis) and developing interpretations of it. As these resulting interpretations are inherently subjective, agencies integrate and reconcile them through discursive practices aimed at cultivating shared meanings of the operational context.

Figure 2: Organizational interpretation as a multi-level process



The stimulus

The interpretative process initiates at the individual level when a stimulus catches the attention of individual actors, puzzling them (Maitlis & Christianson, 2014). The stimulus could take the form of ambiguous information, uncertainty regarding the organizational context, or planned or unplanned events necessitating understanding and approximation (Gephart et al., 2010; Sandberg & Tsoukas, 2015; Weick, 1995). It may originate internally or externally to the organization and can vary in nature (Maitlis & Christianson, 2014). Examples of commonly studied stimuli include launches of new projects (e.g., Fiol, 1994; Gephart et al., 2010), disasters (e.g., Vaughan, 1996; Weick, 1993), or environmental jolts (e.g., Meyer et al., 1990; Sine & David, 2003).

Exposure to stimuli is necessary to trigger the interpretative process, yet it may be insufficient if the stimulus remains unattended (Sandberg & Tsoukas, 2015). Given the limited processing capacity of individuals and the constant influx of information actors need to make sense of, stimuli need to be surprising for the interpretative process to start (Nigam & Ocasio, 2010; Sandberg & Tsoukas, 2015).

In the context of extreme weather events, stimuli stem from the uncertainty or ambiguity surrounding these phenomena, as well as their resulting damages (Boudes & Laroche, 2009). For example, the casualties of the 2003 European heat wave, caught the attention of analysts triggering interpretative process around the event (Boudes & Laroche, 2009). Similarly, Christianson and colleagues (2009) show how the North American blizzard of 2003 caused the collapse of the roof of the Baltimore & Ohio

Railroad Museum, initiating retrospective interpretation among senior leaders, ultimately influencing the long-term actions discussed during executive meetings.

Individual interpretations

Once a stimulus is recognized, actors try to assign meaning to it, forming perceptions regarding its nature, and assessing its potential impacts on agency operations, generating ideas for planning and response (Maitlis & Christianson, 2014). This process entails the transformation of the stimulus from raw data into actionable information (Galbraith, 2023; Gavetti & Warglien, 2015), resulting in the creation of individual interpretations or "cause maps", which are collections of concepts and cause-effect relationships that actors develop to assign meanings to organizational situations (Weick & Bougon, 1986).

However, as the development of cause maps is cognitively demanding, individuals rely on pre-existing interpretations established in analogous situations to assign meanings to the stimulus (Gavetti & Warglien, 2015; Weick, 1969). Professional backgrounds and past experiences serve as the primary sources of interpretations from which actors draw in constructing cause maps (Cornelissen & Werner, 2014; Gavetti & Warglien, 2015; Hambrick, 2007). To this extent, Abolafia (2010) finds that members of the Federal Reserve Committee, interpret reality through the lens of the economic schools of thought in which they have been socialized. Similarly, Gavetti and colleagues (2005) find that managers operating in uncertain and unfamiliar contexts draw upon past experiences to navigate uncertainty and novelty.

These findings suggest that when dealing with extreme weather events individuals develop perceptions of the risks posed by these phenomena, drawing on both their previous experiences and professional expertise. Nowell and Stutler (2020) highlight this dynamic by demonstrating how the interpretation of public managers during the Chimney Tops 2 wildfire disaster was influenced by their memories and professional practices.

From individual to organizational interpretations

While drawing upon past experiences and professional backgrounds facilitates the development of cause maps, it also introduces subjectivity into interpretations (Gavetti & Warglien, 2015; Hambrick, 2007). Moreover, since each actor filters reality through a unique combination of individual experiences and professional standards, discrepant interpretations of the same stimulus may emerge within the same organization (Abolafia, 2010; Daft & Weick, 1984; Dobbie & Brown, 2014). As Eisenhardt and colleagues suggest, those "who have grown up in sales and marketing typically see opportunities and issues from vantage points that differ from those who have primarily engineering experience" (1997, p. 48). Similarly, as shown in the first study, within organizations addressing extreme weather phenomena, differing perceptions of "risk" exist, shaped by individuals' areas of work.

As a result, to construct a shared organizational interpretation, agencies reconcile, align, or integrate actors' interpretations (Cornelissen & Werner, 2014; Kaplan, 2008; Weick & Bougon, 1986). A common theme in much of the literature examining how these processes unfold is the idea that the integration of individual cause maps occurs through argumentative cycles, often termed "framing contests" (Cornelissen & Werner,

2014; Kaplan, 2008; Maitlis & Christianson, 2014). During these cycles, individuals engage in debates and discussions with other actors in an effort to assert their interpretations (Kaplan, 2008; Weick, 1969).

Given the discursive nature of these cycles, research often analyzes the communication mechanisms through which managers question each other's interpretations while advancing their own (Cornelissen & Werner, 2014; Dewulf & Bouwen, 2012; Schmidt, 1991). In particular, literature underscores the role of narratives, and discourses, as tools that allow the convergence of individuals' interpretations (Cornelissen & Werner, 2014; Dewulf & Bouwen, 2012; Kaplan, 2008; Maitlis & Christianson, 2014). For instance, Fiol case study shows the importance of communication for enabling the integration of cause maps (1994).

Even though literature examining the process of reconciling discrepant interpretations of extreme weather is scant, interpretative scholarship strongly indicates the importance of discussions in developing shared interpretation (Ferns & Amaeshi, 2019). More uncertainty however exists regarding the participants and directionality of these cycles (Maitlis & Christianson, 2014). Some posit that only senior leaders engage in these contests, while others suggest the involvement of the entire organization (Daft & Weick, 1984; Isabella, 1990; Maitlis & Christianson, 2014). Additionally, while some research describes organizational interpretations as top-down processes, others advocate for a bottom-up dynamic (Gioia & Chittipeddi, 1991).

Summary

I identify three main gaps that deserve further examination to better understand how the interpretative process unfolds in organizations dealing with extreme weather events.

First, most of the literature examines interpretation processes of past crises, as these processes are attended by several organizational actors, and well-documented, enabling to reconstruct the interpretative process (Gephart et al., 2010; Maitlis & Christianson, 2014). However, while a retrospective approach, describes the structural elements characterizing organizational interpretation, it does not explain how organizational interpretations unfold when organizations deal with ongoing and future-oriented issues (Gephart et al., 2010; Isabella, 1990; Sandberg & Tsoukas, 2015). Hence, in this study, I contribute to the broader interpretative scholarship by asking public managers about the processes through which organizations develop plans to adapt to the threats posed by extreme weather events.

Second, most of the research, particularly that dealing with extreme weather, crises, and climate change examines either sub-organizations like teams (e.g., Weick, 1993) or institutions (e.g., Ansari et al., 2013; Ferns & Amaeshi, 2019). Less literature, instead, examines the elements influencing the construction of shared cause maps at the organizational level as well as the dynamics of these phenomena (Isabella, 1990; Sandberg & Tsoukas, 2015). Nevertheless, understanding how organizations develop shared interpretations of these phenomena is critical, especially considering they are the ones most affected by extreme weather (Gephart et al., 2009; IPCC, 2012). This study, by

describing how individual interpretations are integrated to construct shared cause maps at the organizational level, aims at addressing this knowledge in gap.

Finally, literature often overlooks the role of organizational politics in organization interpretative processes, with calls being made for more research in this area (Maitlis & Christianson, 2014; Sandberg & Tsoukas, 2015; Weick, 2005). In response to these calls, this study examines how actors' power, resources, and authority influence the development of shared organizational cause maps.

Research design and methods

Despite the growth in organizational interpretative scholarship over the past decades, there remains interest in understanding how organizations cultivate shared cause maps of current and future risks. To achieve this goal, a qualitative research design is considered appropriate for several reasons. First, qualitative research allows to examine the formation of socially constructed phenomena, such as interpretations of extreme weather events, answering questions like "what is occurring?" and "how does it occur?" (T. W. Lee et al., 1999; Rynes & Gephart, 2004). Second, qualitative research is useful to investigate the social processes that underlie managerial practices (Marshall & Rossman, 2016) and identify different meanings held by various individuals (Rynes & Gephart, 2004).

This study draws on semi-structured interviews. Interviews are ideal when the aim of the research is to describe and understand processes, sequences of causation, and interactions among organizational members (Marshall & Rossman, 2016; Rubin & Rubin, 2012). Interviews are also useful to uncover participants' experiences, memories,

and views of organizational phenomena, (Marshall & Rossman, 2016; Rynes & Gephart, 2004). Finally, interviews provide information on the different organizational contexts in which organizations operate, allowing to check the validity of the provided answers, especially if respondents come from the same organization and are asked the same questions (Marshall & Rossman, 2016).

Data collection

To identify organizations to interview I adopted a combination of theory-based and maximum variation sampling (George & Bennett, 2005). I selected four transit agencies which were (i) large, (ii) operationally complex, (iii) located across the US, and (iv) had prior experiences with different types of extreme weather phenomena. The criteria ensured comparability across the agencies as all of them had experience with extreme weather and were large and complex enough so that they had discussed plans to prepare for and respond to extreme weather phenomena. At the same time, I identified agencies characterized by sufficient variation with regards to the types and the nature of the extreme weather events experienced (i.e., rate of onset, expected recurrence, and impact dispersion) as those elements could influence risk perceptions. In other words, I selected agencies that would have enabled me to uncover and describe common patterns across different contexts (Marshall & Rossman, 2016; Miles et al., 2020).

The introduction of the dissertation explains why transit agencies are an ideal subsector of organizations for this study. The appendix provides a description of the steps followed to identify the four agencies as well as of the operationalization of the criteria I

adopted to measure them. Table 8 shows the main elements characterizing the interviewed agencies.

Table 8: Characteristics of the interviewed agencies

Agency #	***Population served***	***Directly operated vehicles***	***Modes of service***	***Climate region (NOAA)[8]***	***Extreme weather events experienced[9]***
Agency A	744,444	140	Bus, heavy rail, light rail	Southeast	Hurricanes, coastal storm, severe ice storm
Agency B	2,260,800	2,890	Bus, heavy rail, light rail	Northwest	Snow, Severe ice storm, flood, wildfires
Agency C	3,432,361	2,007	Bus, heavy rail, light rail	Northeast	Coastal storm, severe ice storm, flood, hurricane
Agency D	1,412,140	350	Bus, heavy rail, light rail	Ohio Valley	Snow, Severe ice storm, severe storms

For each agency, I identified all the top managers involved in planning and adaptation to extreme weather events, contacting all the twenty-seven of them. The appendix provides the recruitment email I sent to managers. I interviewed two top managers and reviewed and updated the interview protocol. Following the first five interviews I performed a preliminary analysis and coding of the interviews. I then interviewed other six top managers. During the interviews with top managers, I used a snowball sample approach to identify middle managers for interviews and interviewed

[8] https://www.ncei.noaa.gov/access/monitoring/reference-maps/us-climate-regions
[9] https://www.fema.gov/disaster/declarations

six of them. After interviewing eleven top managers and six middle managers, I reached saturation. Table 9 provides a descriptive overview of the managers interviewed from each agency. Drawing on data from multiple agencies, allowed to identify the unfolding of the interpretative process, above and beyond the organizational setting within participants are embedded.

I conducted the interviews via Zoom from January to April 2023. I video and audio recorded the interviews via Zoom. Following each interview, I re-watched the recorded interview to verify that Zoom transcriptions were complete, adding annotations using the notes I took during the interview as well as non-verbal elements, in order to have verbatim transcriptions of the interviews. The length of the interviews ranged between 45 and 90 minutes. I coded a total of 125 pages of transcribed interviews using NVivo.

To guide the interviews, I developed a protocol aimed at answering the research question guiding the study. The literature review informed the protocol. I used the first two interviews to test and revise the protocol (Rubin & Rubin, 2012). I developed the protocol around four main themes: (i) the organization in general, (ii) past experiences with extreme weather events, (iii) planning for extreme weather events, (iv) planning for other risks. Questions about the organization in general provided me with a contextualized understanding of the agencies. I asked questions on extreme weather events to transition to the primary focus of the interview, which asked about the planning process and the management of discrepant interpretations of extreme weather events within the agency. Finally, I asked managers to talk about other types of risks different

from extreme weather events faced by the agency. The appendix shows the protocol I followed to guide the interviews.

Table 9: Function and rank of the interviewed managers

	Agency A	***Agency B***	***Agency C***	***Agency D***
Function				
Planning	3	2	1	2
Operations	1	2	2	1
Engineering	1	0	1	1
Rank				
Top manager	3	2	2	3
Middle manager	2	2	2	1

Data analysis

I analyzed the interview data following the steps developed by Miles and colleagues (2020). I first developed a provisional list of a-priori, theory-driven codes drawing from organizational interpretations and Daft and Weick's (1984) framework: (i) individual givens; (ii) contested meaning; (iii) framing contests; (iv) directionality. "Individual givens" identified how actors' past experiences or backgrounds influenced the development of intersubjective meanings. "Contested meanings" identified cases in which individuals did not share similar interpretations of the risks posed by extreme weather. "Framing contests" identified cases of argumentations in which actors advocated for their own interpretation. Finally, "directionality" identified mentions of whether the interpretative process followed a bottom-up or a top-down approach.

I subsequently integrated these theory-generated codes with in-vivo codes (Saldaña, 2016), personal impressions, and reflections gathered during the interviews,

along with recurring themes identified among respondents. As this process occurred simultaneously with data collection, I changed and revised some of the deductively identified codes to account for new information and impressions that emerged. This approach facilitated an intuitive identification of key constructs and supported the identification of new codes (Marshall & Rossman, 2016; Miles et al., 2020).

Following this preliminary phase, I proceeded with a line-by-line open coding of the interview transcripts. This involved an iterative process during which I identified, expanded, and annotated preconceived codes while constantly refining them to incorporate new insights gleaned from the interviews. I concluded this process when no new codes emerged. From this first coding cycle, I developed first-order codes, which identified descriptions and elements of the interpretative process (Gioia et al., 2013). I developed definitions for each of the first-order codes to ensure that the same data were coded consistently across the interviews (Miles et al., 2020). To validate the coding process and ensure consistency, I also systematically compared the coded statements.

Subsequently, I revisited the interview transcripts to uncover underlying patterns among the first-order codes. Through this second coding cycle I identified patterns within the data, and defined four second-order themes: (i) heterogeneous risk perceptions; (ii) conversation; (iii) suppression; (iv) shared-experiences (Marshall & Rossman, 2016; Miles et al., 2020). Second-order themes consist of first-order codes and allow to condense large amount of data into smaller, more manageable categories (Gioia et al., 2013). Moreover, they facilitated a more precise understanding and description of the mechanisms through which public agencies dealing with extreme weather phenomena

develop shared interpretations of these phenomena. Comparisons among descriptions of decision-making processes across different agencies further contributed to this process.

Finally, in September 2023, I re-analyzed the interviews and conducted a second coding cycle to ensure alignment between the data and the codes I initially identified (Miles et al., 2020). Where inconsistencies arose, I re-coded the data. Figure 3 provides a graphical representation of the analytical process and the data structure. Table 10 presents both the first-order codes and second-order themes as well as examples of the codes. In total, I coded and analyzed approximately 183 excerpts. Next sections describe in detail the key elements of the process that emerged from the interviews. Direct quotes included in the analysis from the interviews have the following notation: agency, function, rank, and interview ID code.

Figure 3: The analytical process

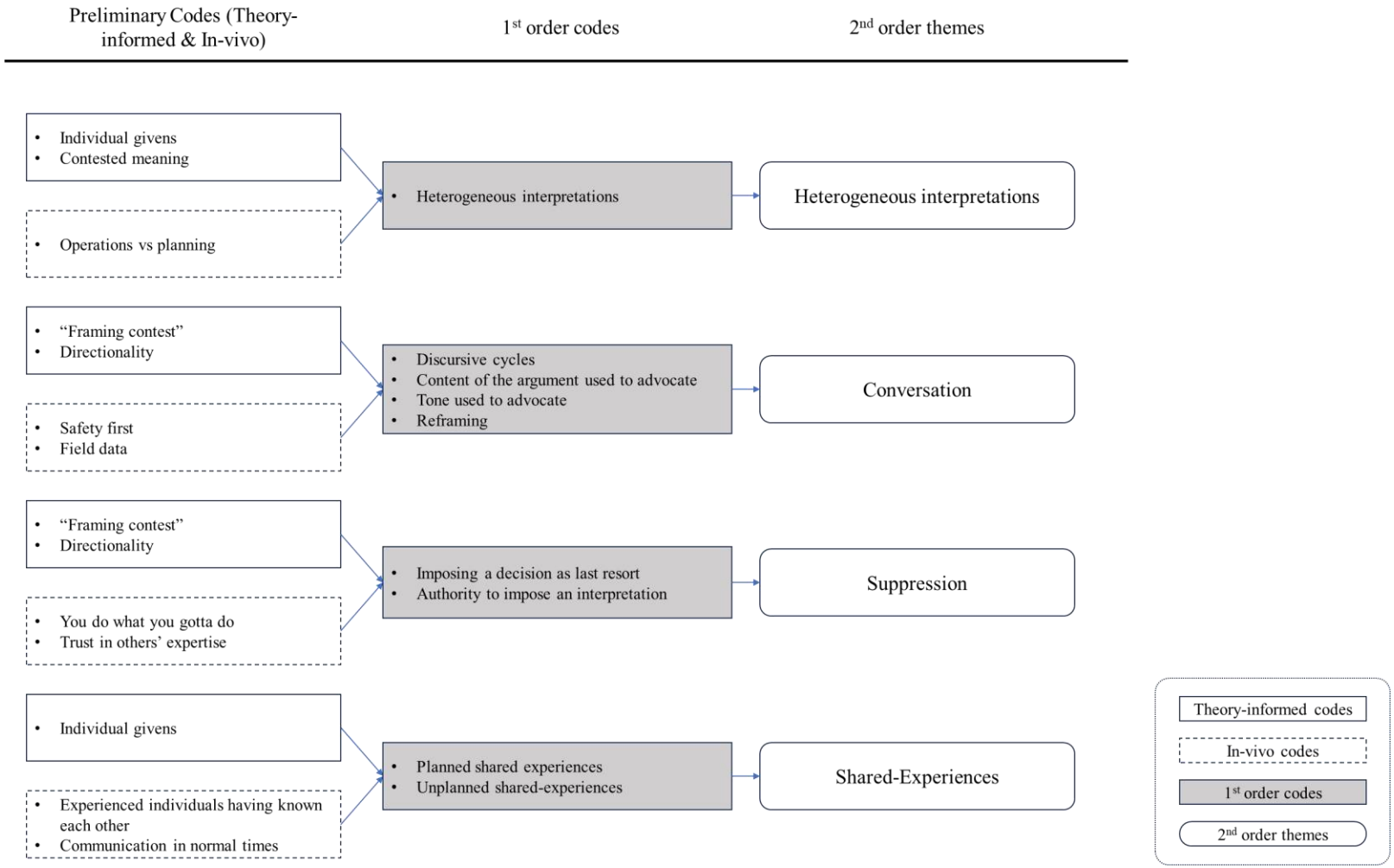


Table 10: First order codes, second order themes, definitions, and examples

2nd order themes	*1st order codes*	*Definition*	*Example*
Heterogenous interpretations	Heterogenous interpretations	Refers to the diversity or variability in how different decision-makers interpret or understand extreme weather events and the threats they pose to the agency.	If you ask 10 people in the organization to give you a list of their top 10 priorities to address inclement weather, and I actually do this at the beginning of the year, you'll see that everybody's list is going to look different (Agency A, Operations, Top manager, 7)
			During planning meetings I often feel like I'm straddling a fence between the superintendents whose work is focused on the here and now and also the planners who are thinking about 5, 10, 50 years from now (Agency B, Planning, Top manager, 14)
Conversation	Discursive cycles	Discussion of discursive mechanisms through which decision-makers addressed heterogeneous interpretations of extreme weather	I listen and I ask a lot of questions, because even if I know the answer, or I think I know the answer, I want to hear it from them. I want them to explain to me from their perspective how they see the problem or what they think the plan to address extreme weather should be. (Agency B, Planning, Top manager, 14)
			To achieve this goal, we have multiple meetings. There are meetings at a higher level, there are meetings at my level and lower level as well (Agency C, Operations, Top manager, 10)
	Content	Refers to the types of information actors convey in communicating and advocating for their interpretations of extreme weather events	Safety thought of possible floodings as life threatening, other departments did not see that as threatening. We ran a vulnerability assessment. We listed all the potential threats that could occur and the likelihood of that threat occurring. (Agency A, Planning, Middle manager, 11)
			If we can show the justification within reason and data and everybody's okay with the proposed plan, we're good. (Agency D, Engineering, Top manager, 9)
	Tone	Refers to the climate and the ways in which actors convey in communicating and advocating for their interpretations of extreme weather events	I'm not the type that holds a grudge. I have to keep it professional and pick up the pieces (Agency B, Operations, Middle manager, 2)
			People need not to take discussions personally. You have to take the personal out of it. It's not personal. It's professional (Agency D, Planning, Top manager, 15)
	Reframing	Description of actors' action to appeal to greater goals and values to silence heterogeneous interpretations of extreme weather risks	When planning for inclement weather, it is essential that they're going to work within our mission and keep everybody focused, so that each of the various disciplines supports the other (Agency A, Planning, Top manager, 3)

			We will focus on customers' safety to ensure that we are doing what we can to overcome the challenges extreme weather may pose (Agency C, Operations, Top manager, 10)
Suppression	Imposing a decision as last resort	Description of a decision on extreme weather planning ultimately made by a individual in a position of leadership due to lack of consensus among actors	I don't know if everybody completely agrees but ultimately there's somebody who says, hey, this is what we are gonna do (Agency C, Engineering, Middle manager, 12)
			If it gets to the point where we keep having differing opinions on the plan, our general manager would end up saying “Okay, here's what we're going to do” (Agency D, Engineering, Top manager, 9)
	Authority to impose an interpretation	Description of how actors utilize their authority, power, or position to impose their interpretations of extreme weather risks	When it comes to extreme weather planning, given my background, they do put a lot of faith in what I have to say (Agency D, Planning, Top manager, 15)
			I believe that in the end it is the leadership that needs to be in charge of employees and the equipment and they need to be the ones in charge of making decisions on how to plan for inclement weather (Agency A, Engineering, Top manager, 13)
Shared-experiences	Planned shared experiences	Description of intentional programs or initiatives aimed at cultivating shared interpretations of extreme weather events, facilitating the planning process.	We have developed this training program because it's important that each one of those departments understand what each function or what other functions do. (Agency D, Engineering, Top manager, 9)
			We are creating opportunities for our leaders to talk more to one another. We’re meeting more at the top level and facilitating more conversations amongst the chiefs in hopes that those conversations are filtering down and facilitate our inclement weather planning (Agency A, Operations, Top manager, 7)
	Unplanned shared-experiences	Description of the role of past experiences or crises in cultivating shared interpretations of extreme weather events, facilitating the planning process.	The thing that we do have that is really good for us is the fact that we have known each other for a long time and we have all of that experience (Agency C, Planning, Top manager, 6)
			It all comes down to experience and relationship. Whether you're in bus operations or facilities you will have folks that have been working for the agency for the past 30, 40 years. They've known each other for a very long time (Agency B, Planning, Middle manager, 8)

Findings

Interviews show that discrepant interpretations of extreme weather events exist within public agencies. Results extend existing interpretative scholarship by showing the role of organizational politics within organization interpretative processes and by identifying different mechanisms through which agencies develop shared interpretations of the risks posed by extreme weather events. Next sections describe my findings and provide some examples coming from the interviews.

Heterogeneous interpretations

Key takeaway #1a: *Multiple interpretations of the risks posed by extreme weather events exist within transit agencies*

Key takeaway #1b: *Discrepant interpretations primarily stem from actors' professional backgrounds*

Evidence from the interviews shows that decision-makers hold discrepant interpretations of the risks posed by extreme weather events. All interviewees but one recounted experiences wherein the formulation of plans to tackle the threats presented by extreme weather events was hindered by conflicting interpretations of these risks, leading to varying preferences on how to navigate them. This phenomenon was observed across both senior and middle management levels. As one manager stated when talking about the planning stage for extreme weather:

"*Dealing with multiple personalities brings you to face diversity of opinions at every opportunity. There's a matter of opinion everywhere, and how we deal with*

other people's perspectives can determine how we make a successful plan [to address extreme weather]" (Agency C, Engineering, Middle manager, 12)

Managers highlighted the presence of divergent interpretations of their operational domain when specifically asked to talk about the decision-making process guiding their agencies' planning for extreme weather phenomena. In contrast, general discussions about organizational culture and climate emphasized the existence of shared understandings. For example, a manager when talking about their agency culture told me: "*Collectively we have a shared vision and a mission we all understand. I would say overall our company is very collaborative, very open to suggestions*". However, when recalling the process through which the agency develops plans to deal with extreme weather phenomena the same manager noted "*each division has different priorities and opinions on the best course of action*" (Agency A, Planning, Top manager, 16).

Interviews also underscore that discrepant views are primarily influenced by the varied professional backgrounds of decision-makers rather than by the diversity of their individual experiences. Several managers highlighted the contrasting viewpoints of departments such as maintenance or customer service as compared to those of strategic and capital planning units. The former, deeply involved in day-to-day operations, perceive extreme weather events as direct threats to agency operations, focusing on adaptive solutions that address the challenges these phenomena may pose on elements like passenger numbers, fare revenues, and routes. In contrast, planners, who have been socialized in contexts that prioritize long-term perspectives, exhibit different perceptions of the challenges posed by these phenomena and how to address them. Specifically,

individuals in these departments lean towards the adoption of more radical solutions able to address agencies' systemic and non-physical vulnerabilities to extreme weather, favoring plans aimed at enhancing infrastructural adaptation, such as relocations. As mentioned by a manager:

> "*You'll always have different risk perceptions. For example, yesterday in our meeting, we spent a long session working on the polarity of operational thinking versus strategic thinking. You know, it's kind of gets it to white collar vs blue collar*" (Agency B, Operations, Top manager, 5)

Conversation

Key takeaway #2a: *Conversations and discursive practices enable the development of shared interpretations of extreme weather events*

Key takeaway #2b: *Content and tone of conversations will influence their effectiveness in developing shared interpretations of extreme weather events*

Key takeaway #2c: *Conversations demand significant resources and time investment to be effective*

Key takeaway #2d: *Reframing allows to communicate an issue broadly enough so that decisions can be made even if individuals hold discrepant interpretations of the external environment*

"Conversation" emerges as a key mechanism through which agencies reconcile discrepant interpretations constructing intersubjective meaning around which consensus can be achieved and action enabled even if individual interpretations remain distinct.

Conversation allows each of the actors involved in the planning activity to advocate for their interpretations of the external environment. Through dialogue, managers develop clearer representations of their operational context, addressing both equivocality and uncertainty, overcoming individual preferences through the development of intersubjective meanings. Several interviews indicate conversation as a key mechanism enabling the development of shared interpretations of reality. For example, when describing their approach to handling the diverse interpretations and perspectives that arose during the planning for extreme weather events, a manager told me:

> "*While planning for inclement weather there's some robust discussions, we present the information that we have, and then the team discusses it and draws reasonable conclusions*" (Agency A, Planning, Top manager, 3)

Conversation content

Interviews also indicate that discussions alone may be ineffective if not characterized by the proper content and form. Content refers to the information used by participants to advance their interpretations. Form, instead, refers to the way in which arguments were made.

With regards to content, a distinction emerged across organizational ranks regarding the types of information used to make arguments and advocate for one's interpretations. Top managers' conversations usually involve what Isabella labeled as "reasoning by analogy" (1990). Specifically, leaders present their interpretations drawing

on past events experienced by the agency. By highlighting either the similarities or the differences between past and present contexts, they aim to demonstrate that their interpretation of the external environment should take precedence over others and guide agency actions (Isabella, 1990). For instance, when asked about meetings aimed at planning for extreme weather events, characterized by discrepant interpretations, a manager noted:

> "*I tell them 'This is what I think we should do. We've tried this before it didn't work. This is why this should go in this way, this is why we're doing what we're doing now"*" (Agency C, Operations, Top manager, 10)

In contrast, middle managers, often lacking the legitimacy and the knowledge of agency history enjoyed by top managers, tend to rely on empirical data to support their arguments and back up their interpretations. Utilizing empirical data serves two purposes: first, it demonstrates their expertise, and second, it motivates others to recognize them as knowledgeable about the agency's operational context. Furthermore, empirical data is typically readily available to individuals in lower ranks, as they are more closely involved in the field and have access to up-to-date information. As one manager explained:

> "*I will basically pull up empirical data that I have and say, 'Hey, for these reasons, these are my concerns if we go with this extreme weather plan. As this plan might have these consequences and these consequences to me it does not seem to be worth it"*" (Agency D, Planning, Middle manager, 4)

Conversation tone

While variations exist in the content of arguments put forth by organizational actors, both top and middle managers consistently underscored the importance of communication style in fostering effective conversations for developing shared cause maps. Respondents emphasized that engaging in heated exchanges of information is acceptable, commonplace, and beneficial, as long as such interactions are conducted with respect and professionalism. Conversations that take a personal turn, instead, may evoke anger and hostility, bringing people to stand firm, hindering the development of shared cause maps.

> "*Discussions during inclement weather planning may happen, but if each division shows their voices and their concerns in a respectful manner, we're able to decide and come to a common understanding of the situation*" (Agency A, Planning, Top manager, 16)

Similarly, when talking about discrepant interpretations characterizing meetings aimed at planning for extreme weather, a manager noted:

> "*I think tone is important. The way you deliver information to that person is very important. I think the tone of the conversation needs to be set from a professional level. I think once the tone is understood, it makes easy to keep a professional outlook. So I think once people accept the tone of the room, the decision on the plan will basically be easier to be made*" (Agency C, Engineering, Middle manager, 12)

Although conversations are recognized as the most effective way to develop intersubjective meaning (e.g., "*I can't stress enough the importance of communicating*" [Agency C, Planning, Top manager, 6]) they are extremely time consuming.

> "*During those planning meetings [for extreme weather] we communicate to make sure that we are all on the same page and we can work as a cohesive team. This takes time…*" (Agency B, Operations, Middle manager, 2)

The reason behind this time demand stems from the fact that individuals' interpretations of their operational domains are rooted in their cognitive schemata (Brown et al., 2015), which must be translated into language before being communicated to others. Consequently, conversations aimed at establishing intersubjective meaning require the prior establishment of a shared language among the involved parties (Crossan et al., 1999). Only then can individuals influence others' interpretations of the external context.

Based on the above, when interaction time is limited, conversations may be ineffective for the development of shared cause maps. This becomes particularly critical when organizations seek to establish intersubjective meaning regarding forward-oriented events. In these cases, the heightened levels of ambiguity and uncertainty that decision-makers must address through conversation to establish a shared cause map will necessitate multiple interactions, taking considerable time, possibly even years:

> "*When it comes to inclement weather [planning], you have folks that have been working for the agency for a very long time. They had the time to know each*

other, to know what each work group does and how it sees the world" (Agency A, Planning, Middle manager, 11)

A special type of conversation: Reframing

While conversations are helpful in providing individuals with a set of shared language and jargons, which then can be deployed to advocate for ones' understanding, they are also adopted to reframe participants' interpretations of the problems by appealing to shared, overarching values and goals embraced by most organizational members. Doing so allows to smooth out cognitive divergences existing among the parties involved in the decision-making process, enabling decision-making. These shared goals are usually the ones presented in organization's mission statements, such as ensuring customer safety, satisfaction, or accessibility. An example of these goals is found in the documentation provided by one of the interviewed agencies:

"*Agency B is responsible for the safe, convenient and reliable delivery of multiple modes of public transit services to the citizens of County B*"

Several managers provided examples of the mechanics behind the reframing process when dealing with discrepant interpretations of the operational context. For example, one of them told me:

"*So we highlight that even if within each division you may have different priorities, collectively we have the primary mission of implementing a proper safe travel for all of our people who need to utilize our services during inclement weather*" (Agency A, Planning, Top manager, 16)

The goals and values to which decision-makers appeal are usually broad and lack specific guidance on implementation. For example, Agency B's mission statement does not specify the mechanisms and decisions necessary to adapt to extreme weather events while ensuring the "safe, convenient, and reliable delivery of public transit services". Using ambiguous goals, however, allows to achieve consensus, as it involves presenting listeners with what they want to hear while strategically withholding details that could lead to discrepant interpretations. This process parallels the "equifinal meaning" argument developed by Donnelon and colleagues (1986). The central idea is that, even when individuals do not share identical cause maps and may not agree on the potential consequences of a decision for the organization, they can still frame the issue at hand in a way that allows everyone to agree on the strategy to follow (Donnellon et al., 1986). This strategy is considered effective by several managers.

> "*If divergencies emerge during extreme weather planning, I tell them that we have customers, and their safety goes first, and so, you know, once you give them that speech, they understand that we're all just butter on the toast and put aside differences*" (Agency B, Operations, Middle manager, 2)

To conclude, interviews underscore the structural and contextual elements that favor the development of shared cause maps through conversations. Structurally speaking, effective conversations present empirical data or show the similarity of the present situation with previous one experienced by the organization. From a contextual perspective, reframing mechanisms facilitate the creation of intersubjective meaning by reducing the time actors need to develop shared jargon.

Suppression

Key takeaway #3a: *Suppression allows to overcome discrepant perceptions of extreme weather events through the imposition of a dominant interpretation*

Key takeaway #3b: *Actors high in rank or perceived as experts put in place suppression*

Key takeaway #3c: *Suppressed actors may resist to suppression developing coalitions*

A second interpretative mechanism which emerged as being often used to address discrepant interpretations of the external environment is suppression. Suppression occurs when an organizational actor imposes their interpretation of the context on others. By doing so, suppression resolves any issues related to heterogenous interpretations of extreme weather phenomena as actors are forced to accept the dominant perspective. The unfolding of suppression directly reflects the power, legitimacy, and political dynamics within the organization.

Some organizations recur to suppression when all the other mechanisms through which intersubjective meaning is developed fail. In these cases, suppression is considered the last resort used by agencies to ensure that an organizational interpretation is developed, and action can follow.

> "*If different departments can work things out amongst themselves, and then get things put into extreme weather plans, that's great, if not who is in charge decides*" (Agency D, Operations, Top manager, 1)

In addition to indecision and failure to reach consensus over the interpretation of the operational domain, suppression also occurs when decisions are dominated by a member characterized by high levels of legitimate or expert power. When individuals who are significantly higher in rank than the rest of the actors involved, they tend to impose their views, exploiting their status.

> "*When you're the king you get to give the direction [for extreme weather planning], and everybody needs to come into life. That's the same thing with day-to-day stuff, if a budget item boils up to my level, I'm going to make a decision, that's the end of it at that point, because I'm the chief executive*" (Agency A, Planning, Top manager, 3)

A similar dynamic occurs when actors who are deemed to be experts in dealing with the issue at hand (e.g., extreme weather), leverage their expertise to impose their interpretations of the risks posed by extreme phenomena and the most adequate ways to adapt to them on the rest of the organization.

> "*When it comes to extreme weather planning, given my background, they do put a lot of faith in what I have to say*" (Agency D, Planning, Top manager, 15)

Differently from conversation, in which all the actors involved in the decision-making process have the possibility to make their arguments and advocate for their interpretation of the context, suppression emerges mainly as a top-down process that is carried out by top managers by virtue of their position and knowledge of the organization. When this happens, interpretations developed through suppression are

accepted by other decision-makers, with individuals avoiding explicit contestations. For example, when talking about planning for extreme weather phenomena, a manager noted:

> "*Sometimes the boss says 'This is how it's going to be', and you may have a difference of opinion, but you're not the boss, so you do what you gotta do*" (Agency D, Planning, Middle manager, 4)

Even if suppression provides the organization with an imposed interpretation of the external context, enabling action to be taken, its effects in the long run may be detrimental. Suppression may trigger resistance from those in disagreement with the imposed interpretation, who would attempt to challenge it. Specifically, middle managers discussed examples of cases in which, when in disagreement with the imposed interpretation, they engaged other decision-makers in conversations in various venues, attempting to develop coalitions of actors that shared interpretations similar to their own. Ultimately, they hoped to change the imposed interpretation of the risks posed by extreme weather.

> "*He would have dominated the [extreme weather] planning meeting and imposed his view. I just had my different opinion and learned how to adjust but I kept trying to convince people about mine*" (Agency B, Planning, Middle manager, 8)

Shared experiences

Key takeaway #4a: *Planned and unplanned shared experiences allows to overcome discrepant perceptions of extreme weather events through the establishment of shared meanings*

Key takeaway #4b: *Shared experiences demand time investment to be effective*

Organizations develop intersubjective meanings of the operational domain through a third mechanism. This process involves having individuals from various departments work together on shared issues and problems. By confronting the same challenges while addressing organizational issues, actors establish a cohesive understanding of reality and gain profound insights into others' cause maps. This heightened familiarity with others' interpretations facilitates the development of shared cause maps by aligning individual interpretations, thus streamlining decision-making and action-taking processes.

> "*And in bringing together others who are exceptional at what they do to routinely work with me, I manage to bring together different perspectives during extreme weather planning meetings*" (Agency B, Planning, Top manager, 14)

The basis for this mechanism lies in the discursive nature of individuals' interpretations, which are shaped by the languages, jargons, and narratives prevalent in their respective operational contexts (Brown et al., 2015). Hence, by bringing people together in various venues and forums, agencies aim to expose individuals to the viewpoints of other departments. Doing so would favor the development of shared narratives and languages that facilitate conversations and create similar interpretations.

Shared experiences can be planned or occur by chance. When planned, they often take the form of training or orientation programs, particularly for new hires. These events provide individuals with insights into the workings of various departments, their priorities, and perspectives. By socializing newcomers into the goals and values of different departments, organizations aim to cultivate interpretations of reality that are

more aligned with each other as they will reflect the collective values of the organization, rather than just those of individual departments. As one manager recalled:

> "*We have developed this program because it's important that each one of those departments understand what each function or what other functions do. When you understand your organization, […], when you understand what facility maintenance do, when you understand what our service quality are supposed to do and their views, extreme weather planning gets easier*" (Agency D, Engineering, Top manager, 9)

Planned shared experiences, however, can extend beyond traditional orientation programs and socialization processes, and their scope may not be limited to new hires. Planned shared experiences may involve senior leaders who are brought together to address routine challenges, such as developing standard operating procedures, establishing new routes, or revising existing schedules. In contrast to the complexity of training new hires, focusing on leaders streamlines coordination efforts by reducing the number of individuals involved. Additionally, organizations hope that, if successfully carried out, these initiatives will foster sustained conversations among departments, even in non-strategic decision-making scenarios, ultimately permeating throughout the organization and facilitating the establishment of intersubjective meanings among all staff members. Managers from different agencies shared this perspective.

> "*So we're, including other divisions in training, in the new initiatives that are being developed, situation reports, SOPs [Standard Operating Procedures]. We*

are all together so that we are on the same page when needed" (Agency A, Planning, Top manager, 16)

When unplanned, shared experiences occur when individuals from different departments come together overtime lacking a specific organizational program that requires them to do so. This often happens in agencies that face numerous crises, where collective efforts are required to overcome challenges. In such scenarios, departments collaborate closely, leading to a shared experience of adversity. As they work together to navigate these crises, individuals naturally develop shared narratives and establish similar interpretations of reality.

"*People have worked together both day in and day out as well as during emergencies or severe weather events. So I think that helps too that they have those relationships and have work together throughout the years.*" (Agency B, Planning, Top manager, 14)

While successful in addressing divergent interpretations, unplanned shared experience mechanisms are constrained by their lack of institutionalization within the organization, a feature that makes their effectiveness contingent upon opportunities for collaboration among individuals. Consequently, established intersubjective meanings may falter when those who have participated in unplanned shared experiences depart from the agency. As one manager shared with me:

"*One of the things that happens is you have retirements and change and so I think we noticed this year when there was a lot of movement after COVID in our vehicle Maintenance Department. Newcomers did not proper understood the*

importance of adopting a long-term [extreme weather] planning perspective"

(Agency B, Operations, Middle manager, 2)

Limitations

Before discussing the contributions of the study for theory and the implications it has for practice, I note some limitations. Methodologically, the small sample size as well as the absence of a team coding effort limit my findings. Specifically, both these elements may have introduced biases or led to oversights that collaborative coding or a larger number of respondents could have captured. To mitigate these issues, I put in place iterative coding cycles, with several months spanning among the different rounds of coding. While this approach did not fully address the issues, it mitigated some of the biases and oversights characterizing single-researcher coding by providing opportunities for reflection and refinement over time.

Second, despite my efforts to triangulate interview data by requesting access to planning documents and meeting minutes from respondents, only one agency granted such access. This limited availability of supplementary documentation poses a constraint on the depth of the analysis, as it restricts my ability to cross-reference and validate interview findings.

Third, since the selection of the agencies from which I recruited participants followed specific criteria, the mechanisms which emerged from the interviews may have limited applicability to large US transit agencies. While I acknowledge this limitation, it is important to note the rationale behind focusing on transit agencies, as outlined in the introduction of the dissertation. Transit agencies offer an ideal context for examining

interpretive processes due to their inherent complexity and the dynamic nature of decision-making within this sector. Furthermore, the core focus of the study is on decision-making amidst uncertainty and ambiguity, phenomena characterizing all organizations, not just large US public agencies. As a result, my findings may be applicable in a broader range of organizational contexts beyond transit agencies (see also conclusion of the dissertation for a broader discussion).

Finally, my description does not consider the evolution of the interpretative process over time. Specifically, while the three interpretative mechanisms provide a snapshot of the processes through which agencies develop shared interpretations of extreme weather events, they fail to describe their deployment during the planning stage.

Discussion

Drawing on interview data about planning for adapting to extreme weather events in four transit agencies, this research provides a description of the processes through which large public sector organizations manage and reconcile heterogeneous interpretations of the risks posed by extreme phenomena.

Findings contribute to both organizational interpretative and public management scholarship by revealing the presence of diverse interpretations of the risks posed by extreme weather events within public agencies. While this result aligns partially with existing research (Daft & Weick, 1984; Hambrick, 2007; Maitlis & Christianson, 2014), it also departs from it. Literature often attributes discrepant interpretations to differences in both actors' experiences and professional backgrounds (Cornelissen & Werner, 2014; Gavetti & Warglien, 2015). This study, instead, indicates that these discrepancies

primarily stem from the varied professional backgrounds of decision-makers. No evidence emerged pointing to differences in personal experiences as a source of discrepant views. This suggests that within large agencies, individuals tend to interpret their operational context primarily through the lens of their departmental affiliations. Consequently, their interpretations are often embedded in the interests and objectives of the functions to which they belong, rather than being rooted in their individual experiences.

The analysis also shows that respondents acknowledged the presence of divergent interpretations of their operational domain when specifically asked to talk about the decision-making process guiding agency planning for extreme weather phenomena. No mention of different interpretations or discrepancies emerged from answers regarding broader discussions on organizational cultures and routines. This finding may be explained further integrating the interpretative scholarship with an attention-based view (ABV) of public agencies (Ocasio, 1997). ABV argues that the attributes of an organizational decision or event will influence actors' attendance and actions towards it (Ocasio, 1997). Hence, it is reasonable to expect that the uncertainty and ambiguity of extreme weather events makes them more puzzling and attention-grabbing (Ocasio, 1997). Consequently, as more individuals engage with the decision-making processes surrounding these events, the likelihood of discrepant interpretations increases (March & Simon, 1993). Alternatively, it may be the case that while discrepant interpretations are ubiquitous in organizational life, they are acknowledged and addressed in specific and distinct episodes as this allows organizations to effectively carry out daily routines and

mundane tasks. As further discussed below, reconciling discrepant interpretations for action to ensue is a time and resource-intensive process. Consequently, if agencies were constantly entangled in resolving these divergent interpretations, their ability to carry out basic activities would be compromised, potentially jeopardizing the organization's continued existence.

The study extends existing theoretical interpretative frameworks to provide a more comprehensive understanding of future-oriented interpretative processes. Extant organizational interpretative scholarship extensively focuses on organizational interpretations of past specific events (Maitlis & Christianson, 2014; Sandberg & Tsoukas, 2015). This emphasis, however, hinders theoretical understanding regarding how public agencies interpret and respond to the threats posed by extreme weather events as it neglects that that interpretation is an ongoing process, which informs consequent action (Daft & Weick, 1984; Gephart et al., 2010).

By describing the mechanisms through which shared interpretations of current and future threats are developed, this study opens the door to connect organizational adaptive scholarship with the interpretative one. A first step in this regard is provided by the interviews which finds three mechanisms through which agencies develop shared interpretations of the risks posed by extreme weather events, enabling decision-making and the undertaking of adaptive actions: (i) conversation, (ii) suppression, and (iii) shared-experiences.

(i) "Conversation" aims at reconciling heterogeneity by addressing both the linguistic and cognitive factors contributing to discrepant interpretations. Through the

engagement of others in conversations, individuals advocate for their own understanding of reality. This process enables the development of shared meanings, enabling actors to describe the reality they perceive in mutually comprehensible ways. Moreover, actors engaged in conversations leverage shared, overarching values and goals commonly embraced by organizational members to deal with interpretative differences among decision-makers. Using ambiguous goals allows to achieve consensus, as it involves presenting listeners with what they want to hear while strategically withholding details that could lead to discrepant interpretations. As a result, even if decision-makers keep different interpretations of the risks posed by extreme weather events they will ignore discrepancies aiming to achieve a higher goal.

While the recognition of the importance of conversation in the interpretative process resonates with extant literature (e.g., Gavetti & Warglien, 2015), interviews extends this finding by showing that effective conversations are characterized by professional and respectful tones. When conversations take a personal turn, they may evoke anger and hostility, bringing people to stand firm, hindering the development of shared cause maps (Weick, 1995).

(ii) "Suppression" is a second mechanism which emerged as enabling reconciliation of discrepant interpretations. Suppression involves top managers leveraging their dominant positions and expertise to silence discrepant interpretations among decision-makers. It involves the imposition of a single interpretation of the operational domain on the organization. Suppression may be implemented either when other interpretative mechanisms prove ineffective or when decisions are dominated by a

member characterized by high levels of legitimate or expert power. Suppression emerges as the quickest means for organizations to develop shared interpretations of the environment, as it bypasses the need to establish a common language.

The concept of suppression and its link to authority not only enriches our understanding of the interpretative process but offers theoretical pathways to further integrate it into classical managerial theories. To this extent, findings from the interviews revealing that suppression can provoke resistance may be linked to Barnard's "zones of indifference" (1966) and inform studies examining how traditional management frameworks could support the undertaking of adaptive actions.

(iii) "Shared experiences" is the third mechanisms that emerged as enabling the reconciliations of discrepant interpretations. It involves individuals from diverse departments collaborating on common issues and challenges. These experiences can be planned, such as cross-departmental training programs aimed at integrating new hires, or unplanned, like crises. In both scenarios, as individuals from various departments collaborate to resolve routine or unforeseen problems, they gradually develop similar perceptions of the world, thus establishing shared interpretations of reality. Furthermore, through shared experiences, individuals construct collective narratives and a unified language that provide them with the means to cultivate intersubjective meaning of reality. Similarly to conversations, shared experiences typically require a significant amount of time to enable the development of shared cause maps.

Finally, the study contributes to both interpretative and public management scholarship by providing clarity on the uncertainty surrounding the directionality of

organizational interpretative processes. Contrary to a strict top-down or bottom-up approach, interviews suggest that interpretation in organizations primarily evolves through feedback loops across departments and ranks (Maitlis & Christianson, 2014).

Findings have also practical implications for public managers. The identification of the three mechanisms provides decision-makers with an enhanced understanding of the processes through which shared interpretations of the external environment can be achieved. This equips public agencies with valuable tools to facilitate action-taking and fosters a more systematic approach to adaptation, reducing their over-reliance on ad-hoc procedures (Zhang & Welch, 2022). In other words, the study provides public agencies with knowledge they can articulate to better adapt to the challenges ahead.

Additionally, as suppression emerges as a solution that can backfire, the study underscores the importance of discourse in agencies that aim to develop homogeneous interpretations of the risks posed by extreme weather. It is through respectful discussion, the sharing of information, perspectives, and points of view that convergence on a cause map of the external environment is achieved. This can be accomplished either through conversations by bringing different people to the table and "*not walking out until a decision is made*" (Agency C, Engineering, Middle manager, 12), or by facilitating shared experiences among individuals. Failing to recognize the existence of multiple perspectives, inhibiting these discussions by suppressing debates and imposing a single interpretation, or relying solely on unplanned events to bring actors together to develop

intersubjective meaning risks to backfire or, worse, be ineffective in enabling decisive action.

CHAPTER 4

THE ACTION-TAKING STAGE

Abstract

This study investigates why some agencies are more likely to adapt to extreme weather events than others. Drawing on organizational learning, interpretation, and climate change adaptation scholarship, I examine the role played by organizational elements in influencing the development of shared cause maps and the undertaking of adaptive actions. I develop hypotheses distinguishing between elements aimed at developing consensus around cause maps' contents, and factors that enable consensus-building on cause maps' framing. I test my expectations drawing on a 2023 national survey of the largest US public transit agencies. Results underscore the importance of "debative cooperation" and cross-agency boundary spanning activities in facilitating the development of shared cause maps and favoring adaptation. Conversely, divergent risk perceptions and the absence of internal discussions are found to hinder adaptation.

Introduction

The final stage of Daft and Weick's (1984) framework is "action-taking". In this phase, organizations translate the interpretations of the external environment (also known as cause maps) developed during the preceding data collection and interpretation stages into concrete actions. Because this phase involves the application of new knowledge to the environment and results in organized action, Daft and Weick (1984) also refer to it as the "organizational learning" stage (Fiol & Lyles, 1985).

While Daft and Weick do not provide a definition of organizational learning (or action-taking), Fiol (1994) builds on their work and defines this phenomenon as a process involving the development of new interpretations of events. This process differs from individual learning in that it requires first reaching a consensus around internally diverse interpretations of the environment before organized action can result (Fiol, 1994).

Fiol's definition aligns with Daft and Weick's information-processing conceptualization of organizations as it highlights the centrality of organizational processes (i.e., consensus development) in motivating action. Moreover, similar to Daft and Weick, it acknowledges that organizational phenomena entail a higher level of complexity compared to individual ones. Hence, in this study I borrow her definition to examine the action-taking stage and investigate a specific facet of organizational learning: adaptation to climate change. Specifically, I answer the following research questions: *Why are some organizations more likely to learn and adapt to extreme weather events*[10]*? What is the role played by internal processes in fostering or preventing adaptation from occurring?*

I conceptualize organizational adaptation as a form of organizational learning because of the interconnections existing between the two phenomena (Meyer, 1982). Although a distinction exists between these two constructs (Fiol & Lyles, 1985) – adaptation encompasses collective and organized responses to experienced or anticipated issues, without necessarily entailing a new understanding of the environment (Ford &

[10] While extreme weather events and climate change are distinct phenomena, recent research increasingly attributes the growing frequency and severity of extreme phenomena to climate change (see for example Estrada et al., 2023; Reed et al., 2022). Consequently, efforts to adapt to climate change must also include measures for extreme weather adaptation.

Baucus, 1987) – adaptation and learning capabilities are so closely intertwined that literature suggests their development processes are almost indistinguishable and that effective organizational adaptations require and involve organizational learning (Cohen & Levinthal, 1990; Ford & Baucus, 1987). This is because learning and the new interpretations it entails not only motivate and guide organized actions but also enable and determine organization selection and survival (Dutton & Dukerich, 1991; Ford & Baucus, 1987; Levinthal, 1991; Meyer, 1982). Moreover, considering adaptation as an aspect of organizational learning allows one to portray it as the result of dynamic internal processes that evolve over time (Pelling et al., 2008). This is consistent with Daft and Weick's interpretative conceptualization of organizational actions (Pelling et al., 2008).

The connection between organizational adaptation and learning has been particularly fruitful in the context of adaptation to climate change, where the two terms have been used almost interchangeably (Berkhout, 2012; Fiol & Lyles, 1985). Climate change adaptation consists in a process of adjustment to actual or expected weather phenomena and their effects, with the ultimate goal of moderating or avoiding harm (IPCC, 2014). This process is often germane to organizational learning for several reasons (Berkhout, 2012; Berkhout et al., 2006; Pelling et al., 2008).

First, learning has been associated with organizational ability to adapt to climate change (Feeney et al., 2022). Second, organizational learning scholarship provides conceptual frameworks for examining the different pathways through which organizations can develop adaptive capacity (Berkhout et al., 2006; Pelling et al., 2008). Last, adaptation to climate change is often theorized as stemming from disasters and

crises, which trigger learning processes by enabling organizations to identify their weaknesses and develop the capacity to manage them (Elliott & Macpherson, 2010; Zhang et al., 2018).

However, research studying climate change adaptation from an organizational learning perspective mostly focuses on technical and structural facilitators and barriers, overlooking the cognitive, social, and organizational processes that underpin action (Crossan et al., 1999; Fiol, 1994). Some studies treat learning and adaptation as purely technical matters, highlighting the role of quantitative methods, such as cost-benefit analysis or portfolio analysis, in determining adaptations to climate change (Bhave et al., 2016; Dittrich et al., 2016). Others emphasize the role of past experiences and failures (Nowell & Stutler, 2020; Tsang & Zahra, 2008). Still others examine the role of financial (Ekstrom & Moser, 2014), institutional (Biesbroek et al., 2011; McNeeley, 2012), leadership (Ekstrom & Moser, 2014; Tribbia & Moser, 2008), and political (Broekema, 2016) barriers to adaptation, with limited discussion of the decision-making processes that can overcome them and trigger action-taking (Biesbroek et al., 2013; Crabbé & Robin, 2006; Eriksen & Lind, 2009; Fiol, 1994). Even when these factors are discussed as determinants of adaptation to climate change, a thorough theorization on how they work is often missing (Biesbroek et al., 2013). Nonetheless, adaptation and learning in organizations stem from internal social and procedural factors, which shape the development of shared interpretations of the environment, and determine action-taking (Crossan et al., 1999; Daft & Weick, 1984; Fiol, 1994). Hence, drawing on the extant interpretative and learning scholarship this study contributes to the extant literature by

examining the organizational elements and dynamics that enable or prevent agencies' adaptation to extreme weather events.

I hypothesize that public transit agencies where decision-makers share similar perceptions of extreme weather risks will be more likely to adapt to extreme weather events. Similarly, I expect those agencies which have in place processes favoring the development of shared cause maps within the organization, such as cross-functional activities, and "debative cooperation" (Schmidt, 1991) to be more likely to adapt to climate change. I test these expectations integrating national survey data collected in 2023 with weather and administrative data provided by the National Centers for Environmental Information (NCEI) and the National Transit Dataset (NTD).

Findings contribute to the broader literature on organizational learning and adaptation to climate change in different ways. First, I expand Daft and Weick's (1984) three stages framework integrating and connecting it to organizational learning scholarship (Crossan et al., 1999; Fiol & Lyles, 1985). Drawing on Fiol's work (1994) and her idea that consensus is necessary to achieve learning and adaptation, I follow Donnellon and colleagues (1986) in distinguishing between processes aimed at developing consensus around cause maps' *content* (i.e., the perceptions of reality) and those directed at cultivating consensus around cause maps' *framing* (i.e., how those maps are depicted and communicated). This allows me to extend organizational interpretative scholarship connecting it to research on organizational learning.

Additionally, by examining the role of consensus development in action-taking in the context of US public transit agencies in need to adapt to extreme weather events, I

illustrate how organizational processes, conversations, and activities spanning cross-functional and cross-agency boundaries influence agency adaptation to climate change.

Finally, empirically speaking, I rely on a measure of risk perception heterogeneity within transit agencies which is preferable to perceptual measures of organizational cognitive diversity commonly adopted by interpretative studies (Harrison & Klein, 2007).

The study also has implications for practice. Public agencies are under increasing pressure to adapt to extreme weather threats, yet they often grapple with limited personnel, resources, and capacity (Ekstrom & Moser, 2014; Miao et al., 2018). In this context, the cultivation of shared cause maps emerges as a pivotal strategy for addressing the risks posed by these phenomena. Whether achieved through the reduction of cognitive and interpretative discrepancies or the utilization of framing and communication techniques, fostering such shared understanding can streamline adaptive decision-making processes, and expedite the adoption of timely and effective solutions and strategies. By elucidating the operational mechanics of these elements, the study aims to inform organizations that aim to adapt to and navigate the challenges posed by extreme weather.

In the next section, I outline the relevant literature and main constructs of my theoretical framework. I then turn to hypotheses, data, and methods. I conclude by discussing my findings and their implications for theory and practice.

Cause maps, risk perceptions, adaptation, and consensus development

Organizational learning and action are multi-level processes that span individual, teams, and organizational domains (Crossan et al., 1999; Daft & Weick, 1984). Both

processes originate at the individual level, as actors subconsciously begin to perceive patterns, similarities, and possibilities characterizing the domain in which they operate. These recognitions can involve both past events or may be oriented to future possibilities or threats, and usually provide individuals with a sense of what may be done (Crossan et al., 1999). As a result of this process individuals develop what Weick and Bougon defined as "cause maps": collections of concepts and cause-effect relationships that actors develop to assign meanings to organizational situations (1986). Cause maps can be characterized along two distinct dimensions: their *content*, which refers to the perceptions of reality individuals hold, and their *framing*, which pertains to the ways in which maps are communicated and arguments constructed (Donnellon et al., 1986; Fiol, 1994; Weick & Bougon, 1986).

Cause map contents and risk perceptions of extreme weather

Cause maps contain the perceptions through which individuals categorize the external environment. These perceptions, however, are not value neutral (March & Simon, 1993). Bounded rationality prevents organizational members from objectively assessing environmental information, hence, to reduce their cognitive burdens, actors rely on their "givens" to make sense of the domain in which they operate (March & Simon, 1993). As a result, individuals' perceptions of the environment are intrinsically subjective, entrenched in belief-systems, trainings, and past experiences, and consist of labels such as "threats" or "opportunities" (Crossan et al., 1999; Fiol, 1994; Hambrick, 2007; Weick & Bougon, 1986).

In the context of extreme weather events, risk perceptions can be thought of the content of the cause maps individuals construct concerning these phenomena. Like other types of content, risk perceptions serve to categorize the characteristics of extreme weather events and assess their potential impacts on agencies' operations (Weick & Bougon, 1986). Moreover, akin to cause map content, risk perceptions result in non-neutral, subjective assessments and labels that can vary depending on the extent to which these phenomena are perceived to be sources concerns for the organization (Wachinger et al., 2013; Weick & Bougon, 1986). Finally, the parallelism between cause maps contents and risk perceptions also seems to hold empirically. Interviews conducted in the second study and survey data presented in the following sections show that similar to cause map content, risk perceptions are entrenched in individual functional backgrounds, and organizational past experiences. Consequently, different organizational members may end up having unique perceptions of the risks posed by extreme weather phenomena (i.e., risk perception heterogeneity). As shown in the following sections, these discrepant perceptions are a function of the number of departments existing within the organization as well as past events experienced by the organization.

Framing cause maps

Since organizational interpretations and decision-making processes are social phenomena resulting from discursive processes, individuals need to translate the content of their cause maps, (i.e., their perceptions) into words, and communicate it to others. Framing refers to the way people construct their argument or viewpoint (Cornelissen & Werner, 2014; Fiol, 1994). Framing encompasses a range of communication mechanisms

(e.g., metaphors, analogies) through which people reconcile their own perceptions and actions, aligning them with those of others, independently of the specific content of their cause map (Donnellon et al., 1986; Fiol, 1994; Weick & Bougon, 1986).

The framing of cause maps is distinct from their content (Fiol, 1994). Consider as an example a group of decision-makers deliberating whether to upgrade a rail station to adapt to extreme weather. Their cause maps may show disparities in both content and framing, with one aspect not necessarily related to the other. From a content standpoint, decision-makers may assign various labels to extreme weather, leading to differing interpretations of its risks. Consequently, some may view the upgrade as unnecessary while others perceive it as crucial for harm reduction. In terms of framing, decision-makers may employ different communication strategies to convey their preferred course of action, with some opting for broad and vague methods such as metaphors (Fiol, 1994). Moreover, how decision-makers communicate and frame their cause maps often remains independent of their specific contents (Donnellon et al., 1986; Fiol, 1994). For instance, instead of framing the decision as dealing with extreme weather adaptation, individuals may discuss it in terms of enhancing service reliability, fostering innovation, and investing in new standards and technology to ensure customer satisfaction and long-term financial stability for the agency.

Recognizing the distinction between framing and content, interpretative scholarship underscores the significant roles played by both dimensions of cause maps in facilitating learning and action-taking (Donnellon et al., 1986; Fiol, 1994; Weick, 1969). Specifically, the development of consensus around perceptions and meanings attributed

to the external environment (*content*), as well as the development of communication mechanisms that ensure similar behavioral implications independently on cause map contents (*framing*), are both theorized to promote coordinated action (Donnellon et al., 1986; Fiol, 1994; Weick, 1969).

Developing consensus around cause maps' content and framing

The development of individual cause maps concludes the individual learning process. However, for organizational learning to occur and action to follow, an additional step is required (Fiol, 1994). Specifically, organizational learning necessitates that actors' cause maps undergo a process defined by Crossan and colleagues as "integration" (1999). During this phase, cause maps are reconciled to develop a shared interpretation of the external environment. Successful integration results in consensus development, mutual adjustment, and negotiated action (Crossan et al., 1999). However, when cause maps exhibit content discrepancies, or when organizations fail to establish processes conducive to collective frames, adaptation is impeded (Fiol, 1994). For example, the lack of consensus among scientists regarding the potential impact of future extreme weather events on sea levels in Venice, Italy, is preventing the city from adapting the infrastructures in place to manage high-water phenomena, making it vulnerable to future floodings (Anzidei & Alberti, 2023; Horowitz & Bubola, 2023).

Integration and consensus development can pertain to both the *content* and the *framing* of individual cause maps (Donnellon et al., 1986; Fiol, 1994; Weick & Bougon, 1986). Consensus around content is achieved within organizations when members share a similar perception of the elements characterizing their external environment (Fiol, 1994).

This entails perceiving the environment in a similar manner and attributing comparable meanings to its constituent parts (Donnellon et al., 1986). Within a public agency, consensus over content may occur when actors hold similar perceptions of the risks posed by extreme weather events and decide to take coordinated action (Schmickl & Kieser, 2008). For instance, in Milan, Italy, decision-makers' shared concerns regarding the increasing severity of storms led to the implementation of grey and green infrastructure projects, such as detention basins and an urban forest (Forestami, 2020). These initiatives aim to enhance the city's adaptability against severe weather phenomena such as the one occurred in October 2023, when nearly a third of the typical monthly rainfall occurred in less than 8 hours (ANSA, 2023).

Consensus around framing, instead, entails the achievement of what Donnellon and colleagues (1986) defined as "equifinal meanings". Equifinal meanings within an organization occur when the content of individual interpretations vary, yet cause maps are framed in a way that leads to similar behavioral implications (Cornelissen & Werner, 2014; Donnellon et al., 1986; Schmickl & Kieser, 2008; Weick, 1969). An example of consensus around framing is illustrated by the city of Hoboken, NJ, where in 2012, the mayor took advantage of a federal program to reconstruct sewers, enhancing their adaptability to severe storms or hurricanes (Barron, 2023). Initially, the initiative faced opposition from both community members and the state's governor, who held differing perceptions of the risks posed by extreme weather and thus, on the proposed plan (Barron, 2023; Brandon, 2022; Kimmelman, 2023). However, the project gained traction and was made possible because instead of being framed as a plan involving

"infrastructural sewer improvements", it was communicated as a series of "multipurpose projects" which could have yielded 2$ return for each dollar invested. This broader and more ambiguous framing, which incorporated both climate change and economic perspectives, facilitated consensus development among decision-makers with differing perceptions of flooding risk, ultimately enabling the project's realization (Brandon, 2022; Kimmelman, 2023).

As cause map content and framing are independent phenomena, so are the processes for developing consensus around them, with both consensus over content and consensus around framing theorized to be distinct (Donnellon et al., 1986). Weick, for example, argues that "sharing of beliefs is not essential to the perpetuation of interlocked behavior" (1969, p. 98). Similarly, Donnellon and colleagues' discursive analysis of a decision-making episode shows that equifinal meanings enable organized action despite differences in perceptions (1986). Finally, from a learning perspective, Fiol's (1994) case study of a project launched by a Fortune 500 company demonstrates that organizational learning can occur in the absence of shared content if consensus around framing exists, and vice versa.

Although Daft and Weick (1984) acknowledge the importance of consensus development for driving action and recognize the significance of shared cause maps in enabling adaptation, they do not specify the mechanisms through which this can be achieved. Hence, they do not make a distinction between the different types of consensus development. Similarly, most of the organizational learning scholarship highlights the importance of discussions to achieve shared cause maps but overlook the dual nature of

consensus (Fiol, 1994; Majchrzak et al., 2012). Even when this dual nature is recognized, research examines consensus around content and consensus around framing separately, overlooking how they may function together in the same situation (Fiol, 1994). Nonetheless recognizing this difference may provide a more nuanced understanding and insights on the mechanisms that enable adaptation and action-taking. Moreover, the distinction could enhance our understanding of organizational decision-making processes in contexts characterized by high levels of uncertainty and ambiguity. By recognizing and examining the effect of both types of consensus development, this study contributes to the interpretative scholarship connecting it to the organizational learning literature. Drawing on this distinction, I develop hypotheses on how the two types of consensus development mechanisms can favor action-taking and adaptation.

Consensus on content: Risk perception heterogeneity

Consensus around content within organizations emerges when members share a common perception of the elements shaping their external environment (Fiol, 1994). When shared perceptions exist within an agency, the process through which organizations make sense of the context in which they operate is streamlined and action enabled (Daft & Weick, 1984; Kaplan, 2008). This occurs as intersubjective meanings are established, facilitating decision-making, and action coordination. Conversely, when multiple perceptions of the external environment co-exist within the organization, content heterogeneity can lead to conflicts and disagreements that reduce mutual understanding, and prevent collective sensemaking and action from occurring (Deutsch, 1969; Jehn, 1997; Lawrence, 1997).

Consensus around cause maps' *content* is especially critical when dealing with extreme weather phenomena. For instance, Weick (1993) shows that when actors lack a common interpretation of their operational domains due to distrust or structural deficiencies, organizations struggle to respond effectively to extreme events such as wildfires. In those cases, sensemaking processes collapse, impeding coordinated action and exacerbating the challenges posed by the phenomena (Weick, 1993). Hence, to ensure effective organizational adaptation, preparedness, and responses to the threats posed by the environment, it is critical to nurture a shared interpretation of its content among decision-makers (Maitlis & Christianson, 2014; Nowell & Stutler, 2020).

Among the different types of shared contents that enable action, risk perceptions play a pivotal role in facilitating adaptation to climate change. Risk perceptions allow individuals to identify signals in the environment that show that something is not going as expected, triggering intersubjective sensemaking (Nowell & Stutler, 2020; Page & Dilling, 2020; Vaughan, 1990; Weick et al., 1999). When these perceptions are shared among organizational members, they enhance situational awareness, empowering effective management of unforeseen events and promoting timely adaptation (LaPorte, 1988; Maitlis & Christianson, 2014; Weick et al., 1999). Consequently, homogeneous risk perceptions can lead to cognitive integration, enabling learning and coordinated actions (Cornelissen & Werner, 2014; Crossan et al., 1999).

Conversely, heterogeneous risk perceptions of the environment may underlie cognitive discrepancies as well as differences in functional backgrounds, and experiences (Dobbie & Brown, 2014; Hambrick & Mason, 1984; Pelled et al., 1999). These

divergences, can undermine interpersonal relationships within the organization, impair the construction of intersubjective meanings, reduce commitments, create dissatisfaction, and generate higher intentions to leave, ultimately hindering organizational performance (Jehn et al., 1999). When such divergences emerge, they may prevent consensus to develop thereby impeding timely decisions (Nemeth & Staw, 1989), ultimately hampering learning and action-taking (Fiol, 1994).

In the context of climate change adaptation, perceptions and cognitive divergencies among actors represent one of the barriers to adaptation most cited in the literature (Moser & Ekstrom, 2010). Risk perceptions influence actor priorities (Grothmann & Patt, 2005; Moser & Ekstrom, 2010), hence when individuals within the same organization have divergent systems of concerns, they also deal with competing interests and priorities, creating stalemate situations, which practitioners suggest to be one of the greatest barrier to adaptation (GAO, 2009). Thus, I hypothesize:

Hypothesis 1: *Agencies characterized by higher levels of risk perception heterogeneity, will be less likely to undertake actions that are adaptive to extreme weather.*

Consensus on content: Cross-functional activities

While heterogeneous perceptions of the risks posed by extreme weather events can hinder adaptation by impairing the construction of intersubjective and shared interpretations, I expect cross-functional activities to facilitate the development of consensus over content, thereby promoting learning and adaptation. This hypothesis is not only informed by interviews conducted with public managers, who emphasized the importance of organizational programs that facilitate mutual understanding and shared

perceptions of the external environment, it is also supported by organizational learning scholarship.

Cross-functional activities entail collective tasks undertaken by two or more functions within an agency to address an issue or achieve a goal (Martin & Eisenhardt, 2010). Cross-functional activities can foster action-taking and learning by facilitating the development of shared cause map contents and enabling the integration and transfer of knowledge (Brown et al., 2015; Majchrzak et al., 2012; Okhuysen & Bechky, 2009). When actors from different functions come together to tackle shared challenges, they collectively attribute similar meanings to the issues at hand (Okhuysen & Bechky, 2009). By working together, members who may not otherwise interact engage in conversations and practices that allow them to translate their diverse perceptions and create a common interpretation of the external environmental context. (Brown et al., 2015; Majchrzak et al., 2012; Okhuysen & Bechky, 2009). Moreover, these processes prompt members to acknowledge others' assumptions of the external environment. This fosters continuous integration of individual self-images and perceptions with those of others, facilitating cause map combinations and expansions, and allowing decision-makers to develop shared meanings and learning (Argyrys & Schön, 1978; Majchrzak et al., 2012; Okhuysen & Bechky, 2009; Tsoukas, 2009).

Cross-functional activities are particularly relevant when agencies face challenges characterized by high levels of uncertainty and ambiguity, such as extreme weather events (Bechky & Okhuysen, 2011). In those cases, these activities, if properly carried out, allow decision-makers to bridge the boundaries between specialized knowledge areas

and develop shared cause maps, which enable coordinated action (Majchrzak et al., 2012). To this extent, Bechky and Okhuysen (2011) identify cross-functional activities as a pivotal tool for organizations to manage threats and unexpected phenomena.

In addition to facilitating the development of shared cause maps, cross-functional activities can also enable the integration and transfer of knowledge. When teams from diverse departments within an agency work together, contributing their expertise to solve a problem, organizational members are exposed to a broader set of perspectives (Cohen & Levinthal, 1990; Taylor & Greve, 2006). This can lead to cross-fertilization of ideas and a more complete understanding of the domain where organizations operate (Taylor & Greve, 2006). Additionally, cross-functional activities promote the sharing of tacit knowledge held by individual departments, which can be utilized to address challenges arising from the external context (Basten & Haamann, 2018; Nonaka & Peltokorpi, 2006). Hence, I hypothesize:

Hypothesis 2: *Agencies that exhibit higher levels of cross-functional activities are more likely to adapt to extreme weather.*

Consensus around framing

While consensus on content emphasizes the symbolic and cognitive aspects of organizations, portrayed as "shared meanings", consensus on framing acknowledges their discursive nature, suggesting that organizational actions are shaped by the narratives, jargon, and language used by decision-makers (Fiol, 1994; Smircich, 1983; Weick & Bougon, 1986). Consequently, rather than focusing on processes and elements that could favor the development of shared contents, consensus around framing examines

communication mechanisms through which shared frames are developed and action can follow.

Moreover, since the two mechanisms center on separate conceptualizations of organizations, research suggests their distinctiveness. Specifically, literature contends that having in place processes favoring consensus over framing ensures organizational action, irrespective of consensus existing around actors' cause maps (Donnellon et al., 1986; Schmickl & Kieser, 2008). Having discussed how consensus on content can enable organizational action and facilitate learning, the next sections present how mechanisms entailing consensus around framing can similarly yield both the outcomes.

Consensus around framing: Debative cooperation and debate avoidance

The idea that consensus around framing can favor adaptation and learning traces back to Weick (1969), who suggests that shared interpretations of the organizational context are not necessary for action. Instead, he argues that action-taking primarily stems from communicative and information-sharing processes (Daft & Weick, 1984; Weick, 1995). Through communication, actors can frame problems in a way that transcends differences in individual cause map contents, enabling learning and action (Donnellon et al., 1986). For instance, employing communication mechanisms such as metaphors enables members to overcome their discrepant interpretations, leading to coordinated action (Daft & Weick, 1984; Donnellon et al., 1986; Maitlis & Christianson, 2014; Weick & Bougon, 1986). Hence, even if diverse cause map contents exist within the agency, communication can foster the development of a shared framing of the problem at hand, motivating organizational action.

Literature provides empirical support for the role of conversations and discussions as mechanisms that facilitate action. For example, institutional amnesia, failures, and disasters are often conceptualized as the results of organizational processes that prevent communication and lead in diminished attentiveness and flawed organizational sensemaking (Stark, 2019; Weick et al., 1999). In the context of adaptation to climate change and extreme weather events, Comfort (2007) posits that miscommunication prevented effective responses to Hurricane Katrina. Similarly, Ansari and colleagues examine how climate change issues have been communicated over time, showing the pivotal role played by consensus around framing in averting tragedies of the commons as "coincident behavioral implications, rather than coincident interpretations, may suffice for collective action" (2013, p. 1035).

A discursive mechanism which is conductive of consensus around framing is what Schmidt defined as "debative cooperation" (1991). Debative cooperation entails a dialectical process aimed at integrating multiple perspectives on a given problem within a frame broad enough to encompass the ambiguous nature of the organizational context (Fiol, 1994; Schmidt, 1991; Weick, 1969, 1995). During this process, decision-makers question each other's interpretations while advancing their own, engaging in open and critical thinking about their cause maps (Weick, 1995). This leads to the development of frames around which consensus is built, that guide organizational action (Donnellon et al., 1986; Schmidt, 1991; Weick, 1995). To this extent, Abolafia's (2010) analysis of Federal Reserve meetings demonstrates the importance of debative cooperation by

showing how developing narratives and policies framed to include as many interpretations as possible facilitates and enables decision-making and action.

Debative cooperation can also foster the discovery of new and more plausible cause maps, along with the development of communication strategies (e.g., analogies, metaphors, indirect language) conductive to action (Donnellon et al., 1986; Weick, 1995). Specifically, during these processes, actors draw on their knowledge of the agency to employ specific verbal expressions and frame their messages. This enables consensus development by presenting listeners with what they want to hear while strategically withholding discrepant elements (Maitlis & Christianson, 2014; Rouleau & Balogun, 2011). To this extent, Cornelissen's (2012) analysis of professionals shows the framing role of metaphors within organizations. Metaphors are found to facilitate "internal alignment", prescribing and enabling action.

Hypothesis 3a: *Agencies that exhibit higher levels of debative cooperation, will be more likely to adapt to extreme weather.*

An environment fostering the free exchange of ideas and feedback among members is essential for debative cooperation to occur (Schmidt, 1991; Weick, 1995). When organizations encourage conversations, actors are more likely to accept others' ideas and rationales, leading to the integration and synthesis of different interpretations into a more general foundation that informs organizational actions (Argyrys, 1993; Crossan et al., 1999; Fiol, 1994). Conversely, when they discourage discussions and arguments, the development of a cohesive frame accommodating discrepant causes and enabling consensus is hindered (Chen et al., 2005; Majchrzak et al., 2012; Shonk, 2023).

Even from a learning perspective the avoidance of conversations is considered detrimental. Conversations are pivotal to the knowledge creation process theorized by Nonaka and Peltokorpi (2006). They enable the combination and recombination of different sources of knowledge, fostering intra-organizational learning. Hence, when they lack, learning is hindered (Basten & Haamann, 2018; Crossan et al., 1999).

Finally, organizations characterized by a culture where members prioritize unanimity and where dissenting voices are suppressed are particularly susceptible to failures and risk taking behaviors (Blatt et al., 2006; Chen et al., 2005). Self-censorship may trigger overconfidence and complacency, thereby reducing the likelihood of taking action to address the challenges posed by external threats (Blatt et al., 2006; Weick et al., 1999; Whyte, 1998; Zhang et al., 2018).

Hypothesis 3b: *Agencies that avoid arguments are less likely to effectively adapt to the challenges posed by extreme weather.*

Consensus around framing: Cross-Agency Boundary- Spanning Activities

Much of the interpretative literature on consensus development focuses on internal organizational processes and their impact on negotiated action (Sandberg & Tsoukas, 2015). However, an exclusive "inward-looking" approach overlooks Daft and Weick's (1984) conceptualization of organizations as open interpretative systems, which posits that external interactions influence how agencies make sense of and respond to their operational context. This becomes particularly relevant when organizations face threats such as extreme weather events, which require actions that extend beyond internal boundaries (Boin & Lodge, 2016; Deslatte et al., 2023). As shown in the first study, interactions with the operational domain inform organization perceptions of extreme

weather phenomena. Consequently, a thorough understanding of the processes conducive to consensus development, action-taking, and learning should consider both internal and external elements influencing them (Cohen & Levinthal, 1990; Deslatte et al., 2023). Here, I examine how partnerships and interactions with external organizations facilitate the development of internal consensus and foster organizational learning.

Establishing partnerships with external organizations fosters internal consensus around framing as partner organizations can function as "boundary objects". Boundary objects are elements used in conversations that accommodate individual interpretations while ensuring a shared framing across actors (Majchrzak et al., 2012; Star & Griesemer, 1989). Like other boundary objects, external actors are utilized as practical representations through which decision-makers frame messages that facilitate consensus development and action-taking within the agency (Majchrzak et al., 2012). For instance, when decision-makers are deliberating over adaptive measures, they can refer to specific initiatives undertaken by partner organizations. These initiatives serve as tangible metaphors, examples, and shared reference points during discussions (Majchrzak et al., 2012). Moreover, their broad scope ensures that even if stakeholders have differing interpretations of the specific decision, they are aligned on how to proceed.

From a learning perspective, when agencies work on their own, they may not be able to fully understand and tap into external sources of information (Cohen & Levinthal, 1990). This preclusion may result in not-invented-here syndromes, which can ultimately hinder adaptation (Cohen & Levinthal, 1990; Levinthal, 1991; Levinthal & March, 1993). Conversely, working with other organizations may allow organizations to assimilate

information from partners, ultimately reducing both uncertainty and ambiguity and easing the decision-making processes (Doberstein, 2016; Häußler & Haupt, 2021). To this extent, research suggests that interactions with external actors ensure information sharing and knowledge exchange and foster the implementation of adaptative practices as a result of mimetic institutional pressures (Zhang, 2023).

Finally, boundary-spanning activities can enable vicarious learning as agencies can learn from peers' experiences without carrying their cost (Levinthal & March, 1993). This is particularly important in contexts like transit agencies, where technological complexity and the potential disruptive consequences of even minor failures preclude extensive experimentation (Weick et al., 1999). In such contexts, agencies must seize the opportunity presented by their peers' failures to extract valuable lessons indirectly, leveraging the experiences of others to inform their own practices and decision-making (Weick et al., 1999). The experiences of other organizations are then integrated with the agency's own experiences, enabling adaptation.

Hypothesis 4: *Agencies that have in place cross-agency boundary-spanning activities are more likely to adapt to extreme weather.*

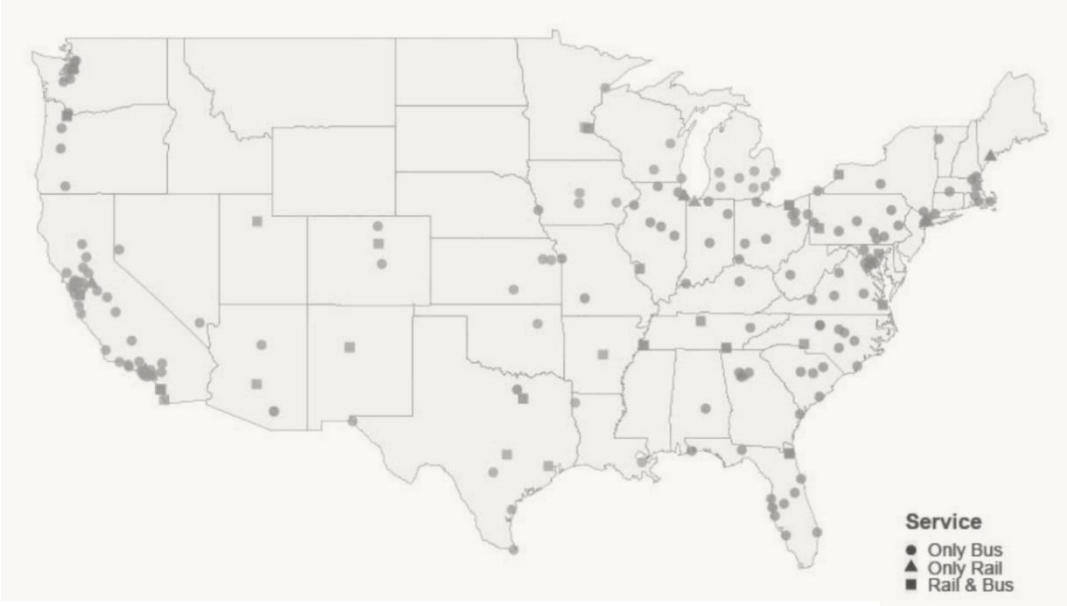
Data and measures

Data

The primary source of data is a survey conducted by the Center for Science, Technology and Environmental Policy Studies (CSTEPS), in 2023. The questionnaire was administered to US transit agencies operating fixed-route bus and rail transit services in metropolitan areas and with annual fare revenues greater than $1 million by 2019. The

survey instruments consist of several questions about organizational culture and environment (e.g., decision-making processes, centralization, routineness); past extreme weather events (e.g., frequency, severity, impact); risk perceptions (e.g., expected frequency and severity); preparation and planning for extreme weather (e.g., upgrades, adaptive measures, coordination with other organizations); and emergency management (e.g., control center functions, changes in decision-making, response plans). The questionnaire was administered to US transit agencies operating fixed-route bus and rail transit services in metropolitan areas and with annual fare revenues greater than $1 million by 2019 (N = 297). For each agency, survey invitations were sent to managers from five different departments: operations, maintenance, service planning, strategic planning, and engineering. The sample includes a total of 1,252 department heads in 297 US transit agencies. Figure 4 reports the geographic distribution of the agencies included in the study. The survey items were tested in previous versions of the survey that were conducted by CSTEPS in 2016 and 2019 on the same sample frame. The research team revised the items according to inputs from previous surveys.

Figure 4: Map of the agencies included in the study



The section on decision-making processes was informed by the interviews conducted for the second study as well as by relevant literature on interpretative processes. Participants' contact information was collected from transit agencies' websites, by calling the agencies and requesting contact information, or through the submission of Freedom of Information Act (FOIA) requests. The survey was administered online over three months, from April 12th to July 25th, 2023. After removing wrong and bad email addresses and managers who had retired or left their position, the sample was reduced to 1,180 eligible individuals.

A total of 372 individuals from 212 agencies completed the survey, yielding an individual-level response rate of 30.8% calculated following the procedure of the American Association for Public Opinion Researchers (AAPOR, RR2, 2023) and agency-level response rate of 71.4%. For 106 agencies responses from multiple managers have been collected (N = 267).

Responding agencies were distributed across 41 states, spanning all climate and administrative regions identified by the National Centers for Environmental Information. These agencies served populations ranging from 53,661 to 18,351,295 individuals, with an average population served of 1,935,043 people. On average, the agencies directly operated 144 vehicles. I conducted non-response bias analysis both at the organizational and individual level to ensure that responding and non-responding agencies/managers are not significantly different in terms of frequency and severity of extreme weather events experienced, organizational size (i.e., VOMS), characteristics of the served area (i.e., density of the served area), geographical location, and areas of work. Results are reported in Table 11 and Table 12 and show that responding and non-responding agencies and managers are not significantly different.

Table 11: Testing selection bias at the organizational level

	Respond to the survey (agency)	
Parameters	***Estimate***	***St. Err.***
Extreme Weather Frequency	-0.09	0.17
Extreme Weather Severity (ln)	-0.01	0.04
VOMS (ln)	-0.02	0.06
Population density (ln)	0.16	0.13
Region: North-East	-0.70	0.44
Region: South	-0.27	0.38
Region: West	-0.26	0.39
Intercept	0.41	1.15
N	297	
* p<0.1, ** p<0.05, *** p<0.01, Standardized coefficients, Reference Categories: Region Midwest		

Table 12: Testing selection bias at the individual level

	Respond to the survey (individual)	
Parameters	***Estimate***	***St. Err.***
Area of Work: Maintenance	-0.33	0.23
Area of Work: Strategic Planning	-0.08	0.21
Area of Work: Service Planning	0.36	0.22
Area of Work: Engineering	0.23	0.21
Intercept	-0.89***	0.17
N	1,252	

* p<0.1, ** p<0.05, *** p<0.01, Standardized coefficients,
Reference Categories: Operations

I matched the survey data with weather data coming from both the Federal Emergency Management Agency (FEMA) and the National Center for Environmental Information's (NCEI) Storm Event Database. The FEMA and the NCEI datasets provide information on extreme weather events frequency and severity, including data on the type of phenomenon experienced, its duration, the affected area, and damages experienced. I use data regarding disasters caused by extreme weather events between 2018 and 2022 (i.e., five years before the survey administration). NTD provides information regarding the financial, operating, and asset conditions of the US transit systems.

Measures

Dependent Variable

I measure adaptation to climate change as a binary variable equal one if transit agencies had put in place at least one of the following measures to prepare for extreme weather events: (i) Invested in new weather-smart equipment and technologies; (ii) Adopted stricter construction and engineering standards to address extreme weather; (iii)

Installed new weather warning systems; (iv) Set aside new funds dedicated for extreme weather events; (v) Implemented green infrastructure projects; (vi) Conducted data analytics or business intelligence to identify areas for improvement to address extreme weather; (vii) Required suppliers to make equipment or vehicle improvements to address extreme weather; (viii) Submitted a grant application for projects to minimize weather impacts. Data come from the survey and suggest that more than a quarter of the responding agencies (26.4%) indicated not having in place no form of adaptation to climate change.

Measuring adaptation as a binary variable is consistent with Daft and Weick framework, as well as with organizational learning scholarship, ensures methodological advantages and is in line with common praxis. Theoretically speaking, Daft and Weick framework suggests that while organizational learning is a multi-level process characterized by feedback and feedforward loops, it fundamentally culminates in one of two potential outcomes: the realization of learning or its absence (Crossan et al., 1999; Daft & Weick, 1984). Methodologically, a binary measure allows for a standardized assessment that accommodates the broad spectrum of contexts and adaptive challenges faced by the transit agencies included in the analysis (Lee & Hughes, 2017). Empirically, a factor analysis showed that the items underscored a single latent variable. Estimates of the factor analysis are reported in the Appendix. Finally, practically speaking, literature has consistently measured climate change adaptation using binary variables (Shi et al., 2015; Zhang, 2023).

Independent Variables

I include five independent variables in the models: **organizational risk perception heterogeneity**, **debative cooperation, debate avoidance**, **cross-functional activities**, and **cross-agency boundary-spanning activities**.

I measure **organizational risk perception heterogeneity** by computing the Euclidean distance existing between managers of the same agency to a question asking about the expected frequency of an extreme weather event occurring within their area in the next year and the impacts the event will have on (i) passenger or operator safety; (ii) transit infrastructure or facilities; (iii) transit vehicles and equipment; (iv) transit ridership and revenues; (v) service provision; (vi) employees' attendance; and (vii) contractors' performance. The questions were informed by literature (e.g., Ho et al., 2008). Similarly Lindell and Perry (2003), risk perception was conceptualized in terms of the certainty and severity of a disaster, including property devastation, and disruption of daily routines and work. Hence, the items about the consequences of extreme weather aimed to measure the expected damages of extreme phenomena on different aspects of transit agencies' organizational life (i.e., operational, financial, and administrative).

An analysis of individual responses regarding perceptions of the risks posed by extreme weather corroborates the findings of the first study. Specifically, an ANOVA (Analysis of Variance) shows that respondents' risk perceptions are significantly predicted by respondents' functional background, and past extreme weather events experienced by the agency. Table 13, reports ANOVA estimates.

Table 13: ANOVA examining determinants of individuals' risk perceptions

Variable	*Sum Sq*	*Mean Sq*	*F-Value*	*p-value*
Area of Work	325	32.54	2.008	0.032
Extreme Weather Frequency	88	88.25	5.445	0.020
Extreme Weather Severity (ln)	116	115.79	7.144	0.008

Within each organization, I compute "the Euclidean distance of one member, *i*, from all the other members, *j*, as the root mean squared distance of each of those *i*, *j* pairs on attribute S" (i.e., risk perception) (Harrison & Klein, 2007, p. 1211). Quantitatively speaking, for each organization the Euclidean distance can be represented as:

$$D = \sqrt{\frac{\sum_{i,j=1}^{n}(S_i - S_j)^2}{n}}$$

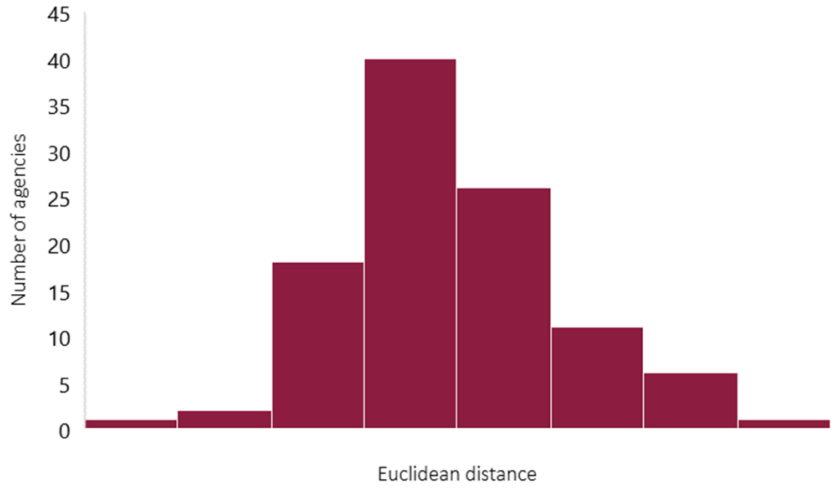
Where *i* and *j* represents two different members within the organization, and n is the total number of members within the organization that responded to the survey (Tsui et al., 1992).

Euclidean distance is recommended to measure cognitive differences, especially when organizational members differ from one another in their position along a single continuous attribute, such as risk perception or organizational commitment, and organizations differ in the extent to which their individual members are collocated along that attribute (i.e., in some organizations members have homogeneous risk perceptions, while in others heterogeneous) (i.e., in some organizations members have homogeneous risk perceptions, while in others heterogeneous) (Harrison & Klein, 2007). Additionally, Euclidean distance is recommended when dealing with diversity in terms of values, beliefs, and attributes (as in the case of risk perception) (Harrison & Klein, 2007). Based

on the above, Euclidean distance was deemed adequate to measure risk perception heterogeneity.

An analysis of the data shows that risk perception heterogeneity has a normal distribution, lending support to the findings of the first two studies which suggest that organizational members do not share similar perceptions of the environments. Figure 5 reports the distribution of the variable.

Figure 5: Distribution Risk Perception Heterogeneity (i.e., Euclidean distance)



To validate interviews' data and findings of the second study, I conducted a linear regression analysis to investigate the predictors of risk perception heterogeneity. The results, presented in Table 14, indicate that the extent of risk perception heterogeneity within an agency is positively associated with the number of departments involved in decision-making activities ($b = 0.18$; $p < 0.01$). These findings suggest that functional backgrounds encompass a distinct set of assumptions that individuals utilize as a lens to interpret and attribute meaning to their reality, thereby serving as a significant predictor

of heterogeneous interpretations of the external environment (Dobbie & Brown, 2014; Eisenhardt et al., 1997; Thornton & Ocasio, 1999).

Consistent with what emerged from the interviews, there is no significant association found between the mode of service provided by the agency or variations in individuals' tenure and risk perception heterogeneity.

Table 14: OLS estimating the determinants of risk perception heterogeneity in transit agencies

Variable	***β***	***Std. Error***
Professional Backgrounds	**0.176*** **	0.061
Extreme Weather Frequency	-0.085	0.132
Extreme Weather Severity (ln)	0.017	0.028
Service: Light Rail	0.067	0.266
Individuals' Tenure (St. Dev.)	0.005	0.023
Intercept	**2.068*** **	0.360
N	106	
R-Squared	0.112	

* p<0.1, ** p<0.05, *** p<0.01, Standardized coefficients

Cross-functional activities is measured as an index from responses to three survey items: (i) people here are encouraged to move between different departments to gain experience; (ii) in this organization, there are no barriers that prevent effective collaborations across departments; (iii) people here collaborate to get the job done, regardless of departmental boundaries. Items come from literature (Lee et al., 2013), response categories ranged from strongly disagree (=1) to strongly agree (=5). Items were informed by the literature and had a Cronbach's alpha of 0.71.

Variables measuring **debative cooperation** and **debate avoidance** were informed by literature (Chen et al., 2005) and come from the 2023 survey. **Debative cooperation**

is an index of three survey items asking respondents the extent to which, when different opinions emerge, people in their agencies "People actively try to integrate different opinions to make a joint decision" "People listen to others' views to find a compromise"; "People seek a solution that is good for everyone". Responses ranged between "none does this" (1) and "many people do this" (4), the index has a Cronbach's alpha of 0.73.

I measure **debate avoidance** by combining three items of the 2023 survey in an equally weighted index with a Cronbach's alpha of 0.86. Managers were asked the extent to which, when different opinions emerge, people in their agencies "People avoid open discussion of diverse opinions to ensure harmony"; "People keep their differences of opinion to themselves to enable decision"; "People discourage others from voicing contrary ideas" (Response categories: 4-point Likert scale 1 = none does this to 4 = many people do this).

I measure **cross-agency boundary-spanning** as a dummy variable from the survey question asking respondents whether their organizations conducted long-term planning with other organizations (e.g., agencies, local governments, MPOs) to address extreme weather events. Among responding agencies, more than a half (57.54%) has boundary-spanning activities in place.

Control Variables

In my models, I include a set of environmental and a set of organizational variables, which literature suggests may foster agencies learning and adaptation to climate change. At the environmental level, I include six main control variables. First, I control for prior experience of extreme weather as these occurrences can serve as

significant reference points, which prospect theory suggests could determine agencies' preferences and actions (Tversky & Kahneman, 1974; Zhang et al., 2018). Specifically, I measure both the frequency and the severity of extreme weather events experienced by transit agencies in the five years preceding the survey administration (i.e., 2018-2022) drawing from the FEMA disaster declarations and the National Centers for Environmental Information (NCEI) in the five years preceding the survey administration (i.e., 2018-2022). Since both FEMA and the NCEI data specify the type of disaster occurred, I consider declarations regarding the following types of emergencies: wildfires, severe ice storm, severe storm, flood, hurricane, typhoon, tornado, snow, and coastal storm (NOAA, 2022). **Extreme weather frequency** is a count variable measuring the number of extreme weather phenomena experienced by the county in which an agency is headquartered has. **Extreme weather severity** is a numerical variable (natural logarithm) measuring the total damages (in USD) caused by the extreme weather phenomena experienced to the county in which an agency is headquartered. As emotional valence is an important predictor of risk perceptions and action-taking, I also included a dummy variable measuring if past extreme weather event has caused any **deaths or injuries** to the served population. The variable is provided by the NCEI.

I also control for some characteristics of the served area (i.e., density of the service area population), and geographical location. Information on the served area **density** (logarithm) is provided by the NTD. Additionally, to account for regional differences in extreme weather events and other factors, I control for the geographic

division in which each agency is located by including four dummy variables: **West, Midwest, Northeast,** and **South** (1 = yes).

Organizational controls include the **types of services** provided, the degree of **centralization** within the agency, the **resources available** to the organization, and the **political barriers to organizational adaptation**. To account for the types of services each agency provides I include a set of three dummy variables in the model: **bus, light rail,** and **heavy rail**.

Centralization is measured as an index from responses to three survey items: (i) top management exerts strong control over this agency, (ii) there can be little action taken here until a supervisor approves a decision, and (iii) even small matters have to be referred to someone higher up for a final answer. 5-points Liker scale, (categories 1 = strongly disagree, 5 = strongly agree), Cronbach's alpha 0.70.

As lack of organizational resources and external influences on decision-making processes are some of the barriers literature suggests can prevent adaptation to climate change (Biesbroek et al., 2011; Ekstrom & Moser, 2014; Moser & Ekstrom, 2010). I include control variables to keep them into account. Using NTD data, I measure **organizational resources** as the natural logarithm of the number of directly operated vehicles (i.e., VOMS). **Political influence** is measured as a an index from responses to four survey items asking managers the extent to which elected or appointed state officials (e.g., governor, legislators), elected or appointed local officials (e.g., mayor, mayor council), State department of transportation, other state agencies, and federal agencies (e.g., Federal Transit Administration, US DOT) influenced agencies' decision-making

processes (5-points Liker scale, 1 = No influence, 5 = very strong influence), Cronbach's alpha 0.74. Similarly, **stakeholders' influence** is measured as an index of responses to four survey items asking managers the extent to which utility service organizations, local businesses, community and neighborhoods associations, and advocacy groups influenced agencies' decision-making processes (5-points Liker scale, 1 = No influence, 5 = very strong influence), Cronbach's alpha 0.84.

Table 15 presents the descriptive statistics for the variables and their sources. Correlations among variables are reported in Table 16.

Table 15: Summary statistics

Variable	N	Mean	St. Dev.	Min	Max	Source
Dependent Variable						
Adaptation to climate change	105	0.73	0.44	0.00	1.00	Survey
Independent Variables						
Risk Perception Heterogeneity	106	3.03	1.02	0.00	7.48	Survey
Cross-functional activities	104	3.41	0.63	1.00	4.67	Survey
Debative Cooperation	106	3.80	0.53	2.50	4.83	Survey
Debate Avoidance	106	2.44	0.46	1.50	3.83	Survey
Cross-Agency Boundary-spanning	106	0.58	0.50	0.00	1.00	Survey
Environmental Control Variables						
Extreme Weather Frequency	106	2.55	3.38	1.00	16.00	FEMA
Extreme Weather Severity (ln)	106	4.85	3.74	0.00	15.76	NCEI
Extreme Weather Impact (death)	106	0.16	0.37	0.00	1.00	NCEI
Density (ln)	106	7.86	0.43	7.03	8.85	NTD
Region: Northeast	106	0.12	0.33	0.00	1.00	NOAA
Region: South	106	0.28	0.45	0.00	1.00	NOAA
Region: Midwest	106	0.21	0.41	0.00	1.00	NOAA
Region: West	106	0.39	0.49	0.00	1.00	NOAA
Organizational Control Variables						
Service: Bus	106	0.92	0.28	0.00	1.00	Survey
Service: Light Rail	106	0.07	0.25	0.00	1.00	Survey
Service: Heavy Rail	106	0.24	0.43	0.00	1.00	Survey
Centralization	104	2.86	0.51	1.83	4.33	Survey
VOMS – Directly Operated (ln)	106	3.59	2.08	0.00	7.93	NTD
Centralization	104	2.86	0.51	1.83	4.33	Survey
Political Influence	105	1.33	3.04	1.33	4.33	Survey
Stakeholders Influence	104	1.13	2.25	1.13	4.13	Survey

Table 16: Correlation matrix

#	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	Adaptation	1																			
2	Risk perception heterogeneity	-0.14	1																		
3	Cross-functional activities	-0.08	0.05	1																	
4	Debative cooperation	0.11	-0.01	0.45*	1																
5	Debate avoidance	-0.17	0	-0.2*	-0.42*	1															
6	Cross-Agency Boundary-spanning	0.32*	-0.09	-0.02	0.05	-0.18	1														
7	Extreme Weather Frequency	0.07	-0.02	-0.04	-0.09	0.06	0.06	1													
8	Extreme Weather Severity (ln)	-0.08	0.05	-0.03	0.00	0.09	0.11	0.36*	1												
9	Extreme Weather Impact (death)	0.14	0.05	-0.02	-0.09	0.05	0.04	-0.12	0.09	1											
10	Population density (ln)	0.10	-0.01	0.08	0.08	-0.06	-0.02	0.00	-0.28*	0.03	1										
11	Region: South	-0.10	0.11	-0.07	-0.17	0.01	-0.02	0.06	0.28*	-0.16	-0.35*	1									
12	Region: West	0.17	-0.04	0.06	0.10	-0.08	0.09	-0.21*	-0.31*	0.13	0.66*	-0.5*	1								
13	Region: North-East	-0.17	-0.09	0.02	0.15	0.04	0.08	0.16	0.16	-0.09	-0.20*	-0.23*	-0.30*	1							
14	Region: Midwest	0.03	0.00	-0.01	-0.05	0.05	-0.15	0.05	-0.06	0.09	-0.24*	-0.32*	-0.41*	-0.19*	1						
15	Mode: Bus	0.12	-0.06	0.03	0.02	-0.02	0.08	0.13	0.28*	0.04	-0.46*	0.04	-0.18	0.01	0.16	1					
16	Mode: LightRail	-0.13	0.10	-0.03	-0.05	-0.04	-0.04	0.12	0.08	0.18	0.28*	0.09	0.06	0.06	-0.23*	-0.31*	1				
17	Centralization	-0.05	-0.01	-0.44*	-0.22*	0.28*	-0.06	0.18	0.08	-0.09	-0.02	0.02	-0.14	0.16	0.02	-0.08	0.24*	1			
18	VOMS (ln)	0.14	0.12	-0.14	-0.02	0.00	0.09	-0.07	0.15	0.18	-0.20*	0.05	-0.16	0.02	0.12	0.29*	0.00	0.08	1		
19	Political Influence on DM	0.10	0.06	0.02	0.07	-0.14	0.29*	0.06	0.15	0.11	0.19	0.04	0.14	0.07	-0.28*	-0.06	0.23*	0.10	0.16	1	
20	Stakeholders influence on DM	0.18	0.05	0.11	0.02	0.13	0.07	0.11	0.00	0.08	0.34*	-0.16	0.36*	-0.23*	-0.08	0.11	0.07	-0.12	0.13	0.34*	1

* Correlation is significant at the 0.01 level (2-tailed)

Results

Because one of the key dependent variables measures cognitive diversity within agencies, I restricted the analysis only to those agencies for which I recorded more than one response as those were the ones for which I was able to measure risk perception heterogeneity. While limiting the analysis to this sub-population may have introduced selection bias, I have run some tests (discussed more in detail below) that seem to mitigate this concern.

Since the main outcome variable is dichotomous, a binary logistic model seems appropriate to test my hypothesis (Long, 1997). Due to the strong and significant correlation between the variables of debative cooperation and debate avoidance, to address concerns about multicollinearity (O'Brien, 2007), I conduct hypothesis testing using two separate models. Both models comprise the same set of variables. However, Model 1 focuses on and tests the hypothesis related to debative cooperation, while Model 2 examines the hypothesis associated with debate avoidance.

To further validate that splitting the hypothesis testing across two models addresses multicollinearity concerns, I run a variance inflation factor (VIF). VIF is used to detect multicollinearity, with low VIF values implying orthogonality among the variables and, thus, lack of collinearity issues. VIF values higher than four to indicate risks of multicollinearity (O'Brien, 2007). Table 17 presents VIF estimates for each variable included in the models, along with the square roots of the VIF values. This additional metric serves as a measure of how much larger each standard error is compared to its value in a model where variables are completely uncorrelated. The

average VIF in each model is equal to 1.73. All VIF values are lower than 4, and VIF square roots are lower than 2, minimizing multicollinearity concerns.

Table 17: Estimates Variance Inflation Factor (VIF) for the two models

	Model 1		Model 2	
Variables	VIF	VIF^(1/2)	VIF	VIF^(1/2)
Independent Variables				
Risk perception heterogeneity	1.34	1.16	1.30	1.14
Cross-functional activities	1.50	1.22	1.30	1.14
Debative cooperation	1.40	1.18	-	-
Debate avoidance	-	-	1.43	1.20
Cross-Agency Boundary-span	1.41	1.19	1.49	1.22
Control Variables				
Extreme Weather Frequency	1.70	1.30	1.66	1.29
Extreme Weather Severity (ln)	1.71	1.31	1.64	1.28
Extreme Weather Impact	1.38	1.18	1.48	1.22
Density (ln)	3.45	1.86	3.06	1.75
Region: South	1.75	1.32	1.64	1.28
Region: West	1.62	1.27	1.72	1.31
Region: North-East	1.60	1.26	1.58	1.26
Mode: Bus	2.28	1.51	2.26	1.50
Mode: Light Rail	2.19	1.48	2.31	1.52
Centralization	1.41	1.19	1.61	1.27
VOMS (ln)	1.59	1.26	1.55	1.24
Political Influence	1.46	1.21	1.48	1.22
Stakeholders influence	1.67	1.29	1.68	1.30

The logistic regressions equation for estimating how decision-making processes influences agencies' likelihood to adapt to extreme weather for the first model is the following:

$$Adaptation = \beta_{0j} + \beta_{1j}RiskPercHet + \beta_{2j}CrossFunctionalCollab + \beta_{3j}DebativeCoop + \beta_{4j}CrossAgencyBoundary + \beta_{5j}EWFrequency + \beta_{6j}EWSeverity + \beta_{7j}EWImpact + \beta_{8j}DensityServedArea + \beta_{9j}Region + \beta_{10j}ServiceMode + \beta_{11j}Centralization + \beta_{12j}VOMS + \beta_{13j}PoliticalInfluence + \beta_{14j}StakeholderInfluence$$

For the second one model the equation is as follows:

$$Adaptation = \beta_{0j} + \beta_{1j}RiskPercHet + \beta_{2j}CrossFunctionalCollab + \beta_{3j}DebateAvoidance + \beta_{4j}CrossAgencyBoundary + \beta_{5j}EWFrequency + \beta_{6j}EWSeverity + \beta_{7j}EWImpact + \beta_{8j}DensityServedArea + \beta_{9j}Region + \beta_{10j}ServiceMode + \beta_{11j}Centralization + \beta_{12j}VOMS + \beta_{13j}PoliticalInfluence + \beta_{14j}StakeholderInfluence$$

Table 18 presents my results and shows that the models are consistent. Results also hold under alternative specifications. For instance, as a robustness check, rather than measuring risk perception heterogeneity using the Euclidean distance, I also measure it by computing the standard deviation characterizing respondents' answers when it comes to risk perceptions, as this measure was mostly adopted by seminal studies on cognitive differences. Results are consistent with those presented here.

The presentation of findings and the following discussion is centered on each of the hypotheses outlined previously, with a focus on examining the significance and

direction of the correlations between the independent variables and the primary dependent variable. Coefficients with a p-value below 0.10 are deemed statistically significant for the purpose of this analysis. Opting for this threshold reinforces my theoretical expectation regarding the pivotal role of conversations and discussions in shaping adaptive behaviors. Furthermore, empirically speaking, the analysis comprises 106 observations. Thus, utilizing a significance level of 0.10 allows to detect potentially meaningful relationships that might not attain conventional levels of significance due to the constraints of statistical power.

The coefficients of the logit models represent the change in the log-odds of the outcome variable associated with a one-unit change in the independent variable, holding all other variables constant (Long, 1997). As these estimates are challenging to interpret, I report average marginal effects (AMEs) alongside the coefficients from the logistic regression model to improve clarity. AMEs measure the average change in the probability of the outcome variable for a one-unit change in the predictor variable, holding all other variables constant (Long, 1997).

Both the models support my expectations regarding the role of people in shaping adaptation to climate change (Hypothesis 1). I find that agencies characterized by higher levels of risk perception heterogeneity would be less likely to adapt to climate change ($B = -0.61$ $p<0.05$ and $B = -0.59$ $p<0.05$). More specifically, estimates for both the model suggest that a one-unit increase in risk perception heterogeneity is associated with a 8% ($p < 0.05$) reduction in the probability of undertaking actions that are adaptive to extreme weather holding all other variables at their means.

I do not find support for my second hypothesis which expected cross-functional activities to be positively associated with adaptation to extreme weather events.

Hypothesis 3a posits that agencies that exhibit higher levels of debative cooperation are more likely to adapt to extreme weather. Estimates find support for the hypothesis and suggest that organizations characterized by higher levels of debative cooperation are also more likely to undertake adaptive actions to extreme weather ($B = 1.18$; $p < 0.05$).

Hypothesis 3b contends that agencies where conversations are avoided are less likely to adapt to extreme weather phenomena. Debate avoidance has a negative and significant coefficient, showing support for the hypothesis ($p<0.1$).

Estimates support my fourth hypothesis. Specifically, average marginal effects of both the models indicate that having in place cross-agency boundary-spanning activities increases the probability of adapting to extreme weather by 0.25 ($B = 1.90$; $p<0.05$ in model 1 and $B = 1.94$; $p<0.05$), holding all other variables at their mean.

Table 18: Estimating agencies' likelihood to adapt to extreme weather events

	Model 1			Model 2		
Parameters	Est.	AME	Std. Err.	Est.	AME	Std. Err.
Independent Variables						
Risk perception heterogeneity	**-0.61****	**-0.08****	0.31	**-0.59****	**-0.08****	0.30
Cross-functional activities	-0.89	-0.12	0.61	-0.50	-0.07	0.56
Debative cooperation	**1.18****	**0.15****	0.61	-		-
Debate avoidance	-	-	-	**-1.37***	**-0.18***	0.70
Cross-Agency Boundary-span	**1.90*****	**0.25*****	0.65	**1.94*****	**0.25*****	0.67
Control Variables						
Extreme Weather Frequency	**1.01****	**0.13****	0.46	**0.89***	**0.12***	0.47
Extreme Weather Severity (ln)	**-0.17***	**-0.02***	0.09	**-0.15***	**-0.02***	0.09
Extreme Weather Impact	**2.17****	**0.28****	1.10	**2.32****	**0.30****	1.15
Density (ln)	0.27	0.04	1.13	0.31	0.04	1.05
Region: South	0.52	0.07	0.90	0.44	0.06	0.88
Region: West	0.97	0.12	1.17	0.88	0.11	1.13
Region: North-East	-1.29	-0.19	1.02	-0.93	-0.14	1.00
Mode: Bus	-0.02	0.00	1.34	-0.10	-0.07	1.36
Mode: Light Rail	**-1.76***	**-0.23****	0.92	**-2.02****	**-0.26****	0.95
Centralization	0.07	0.01	0.67	0.50	0.07	0.70
VOMS (ln)	0.25	0.03	0.16	0.21	0.03	0.16
Political Influence	0.03	0.03	0.53	-0.22	-0.03	0.54
Stakeholders influence	0.61	0.08	0.68	0.87	0.11	0.69
Intercept	-6.30		9.28	-0.73		8.67
N		104			104	
Nagelkerke R2		0.35			0.34	

* p<0.1, ** p<0.05, *** p<0.01,
Standardized Coefficients,
Reference Categories: Region Midwest and Service Heavy Rail
AME: Average Marginal Effects

Among the control variables, environmental factors emerge as the most significant predictors of adaptive behaviors among transit agencies. Consistent with existing literature (Zhang et al., 2018), agencies exposed to extreme weather events with higher frequency levels are more inclined to adapt to such phenomena (B = 1.01; p<0.05 in model 1; B = 0.12; p<0.1 in model 2). The increased occurrence of extreme weather

events likely triggers sense-making processes within the organization, thereby enhancing the likelihood of action-taking to deal with extreme weather phenomena.

Estimates also suggest that agencies serving areas where extreme weather events have resulted in deaths or injuries show a significantly higher propensity to adapt to extreme weather phenomena ($B = 2.17$; $p<0.05$ in model 1; $B = 2.32$; $p<0.05$ in model 2). In contrast, agencies operating in regions where extreme weather events have caused costly damages are less likely to adapt ($B = -0.17$; $p<0.1$ model 1; $B = -0.15$; $p<0.1$ model 2). This seemingly contradictory finding may be attributed to the heightened public attention and emotional impact associated with deaths or severe injuries, which motivates organizations to adopt proactive measures to mitigate future harm. Conversely, costly damages may not be so attended while further straining an organization's capacity to adapt, particularly when agency's focus is on restoring the status quo rather than putting in place long-term adaptive strategies (Zhang et al., 2018).

Limitations

Before discussing the implications these results have for theory and practice, it is important to acknowledge the limitations of this study. While including in the analysis only agencies for which more than one respondent took part in the survey allowed me to actually measure risk perception heterogeneity, it inevitably reduced the number of observations included in the analysis. This decision may have limited the statistical power of my analysis and could have introduced selection bias, meaning that the agencies analyzed could be disproportionately associated with the undertaking of adaptive actions to extreme weather.

To mitigate selection bias concerns, I have run a Heckman correction model. The Heckman model is a statistical technique used to account for and correct sample selection bias. The model consists of two equations, a selection equation and an outcome equation. The selection equation models the probability of being selected into the sample (i.e., the likelihood of more than two respondents from an agency participating in the survey), using a logit model, estimating factors influencing the selection process. I hypothesize that individuals from larger organizations, which have dealt with frequent and severe extreme weather events, may be more inclined to participate, perceiving the survey as more relevant. Consequently, the selection model predicts participation likelihood based on past events, organizational size, and served population. The outcome equation estimates the relationship of interest (i.e., it runs the same model used to test hypotheses), controlling for the selection process. Specifically, the outcome equation includes a correction term, the inverse Mills ratio, which adjusts for the selection bias. If the Mills ratio is not significant, the equations can be assumed to be independent and estimated separately. By jointly estimating selection and outcome models, the Heckman model allows researchers to account for sample selection bias and obtain more unbiased estimates of the relationships between variables. Results, reported in the Appendix, minimize selection bias concerns.

To address concerns regarding the low number of observations and the low statistical power of the models, I implemented three empirical strategies. First, I run a simplified, smaller model that incorporated only six control variables. This approach allowed for a higher degree of freedom, ensuring more than 10 observations per

independent variable, as recommended in the literature (Peduzzi et al., 1996). Estimates are consistent with those presented here and reported I the Appendix. Second, I ran the same models using a penalized maximum likelihood estimation (PMLE), which adjusts the biases in logistic regressions' estimates caused by small sample sizes and rare events (Rainey & McCaskey, 2021). Also in this case, results are shown in the Appendix and align with the findings presented here. Third, I conducted a simulation-based sensitivity analysis to assess the robustness of the statistical models. Specifically, I employed a Monte Carlo Simulation to generate synthetic data based on the original model and subsequently evaluated the stability of the model by fitting it to these simulated datasets. The simulated results demonstrated consistent directionality and significance levels in approximately 78% of the simulations.

The study has also some measurement limitations. While measuring adaptation to climate change as a binary variable has theoretical and methodological advantages, it also limits our understanding of the phenomena investigated. For instance, it does not allow us to fully understand the breadth of the adaptive actions and the extent to which they are the result of internal decision-making policies or imposed by external actors. It may be the case that the adoption of stricter standards to address extreme weather was mandated by federal or state agencies and its implementation has nothing to do with risk perception heterogeneity internal to the organization. Future research should address this limitation by measuring more in detail the extensiveness of the adaptive solutions put in place (e.g., were they pilot programs or were they large-scale adaptive efforts) and the extent to

which such measures were determined by processes transcending the internal organizational dynamics.

Finally, there may be some limitations related to the survey methodology and the nature of the questions asked. For example, questions about arguing may be characterized by social desirability biases, causing the overreporting of collaborative resolution methods and the underreporting of avoidance management styles. To address this limitation, the research team paid extra attention during the survey design stage to put in place solutions that could have addressed social desirability. For example, respondents were ensured anonymity and the survey was administered electronically, two features that the literature suggests contribute to addressing social desirability (Krumpal, 2011). Additionally, the team adopted the "nominative" technique to ask these questions. In particular, this design strategy consists of asking respondents about the behavior of managers and departments other than their own, and it allows for improved behavioral estimates (Miller, 1985).

Discussion

In this study, I draw on organizational integrative, learning, and adaptation scholarship to investigate the decision-making mechanisms and factors that enable public agencies to undertake climate adaptive actions. Extending Daft and Weick framework and recognizing that organizational learning requires consensus-building to drive action (Fiol, 1994), I differentiate between processes that facilitate consensus on *content* and those that enable consensus around *framing*. Results are robust to alternative

specifications and support most of the theoretical expectations about the role played by content and framing of interpretations in determining adaptation to climate change.

Findings regarding the role of risk perception heterogeneity indicate that when individuals within an organization hold discrepant interpretations of extreme weather, agencies are less likely to adapt to climate change. This resonates with the idea that heterogeneous perceptions of the external environment, attributable to factors such as distinct professional backgrounds, may underlie discrepancies in the contents of cause maps. These discrepancies can hinder the integration process and impede consensus development, preventing action and learning from occurring (Crossan et al., 1999; Dobbie & Brown, 2014; Fiol, 1994).

Contrary to expectations, findings suggest that cross-functional activities do not appear to enhance adaptation efforts. Several factors may contribute to this unexpected result. First, the effectiveness of cross-functional activities may be impeded by entrenched departmental perspectives, which create siloed mindsets (Majchrzak et al., 2012). When members involved in cross-functional activities view the world primarily through the lens of their respective departments, and are reluctant to engage in critical reflections, intersubjective meaning giving may not occur, resulting in inaction (Majchrzak et al., 2012).

Even when members actively participate in cross-functional activities, the support and commitment of organizational leaders to the outcomes and recommendations that emerge from these collaborations may be lacking. Leadership buy-in and support are paramount when it comes to successfully adapting to challenges such as climate change

(Ekstrom & Moser, 2014). Therefore, even if team members are engaged in cross-functional activities, the absence of alignment within leadership or their failure to endorse the conclusions reached by these collaborative efforts can prevent action-taking from occurring.

Last, cross-functional activities often occur within constrained time frames and for projects with limited scope (Majchrzak et al., 2012). Consequently, the opportunities for team members to interact and develop shared cause maps may be restricted. These brief and focused collaboration instances may not afford sufficient time for participants to foster the deep understanding and cohesion necessary for effective adaptation efforts.

Similarly to Weick's argument (1995), I find that action-taking can result from communicative and information-sharing processes. These mechanisms empower actors to reframe problems, transcending differences in their individual cause map contents and thereby facilitating learning and adaptation. In particular, engagement in debative cooperation, where actors openly and critically analyze their interpretations of the environment, can lead to the identification of new and more plausible cause maps (Schmidt, 1991; Weick, 1995). Additionally, debative cooperation can lead to the formulation of communication strategies, such as analogies, metaphors, or indirect language, that are conducive to taking action (Donnellon et al., 1986).

Avoiding discussions and prioritizing unanimity may prevent integration and consensus development from occurring. Lacking discussion, members fail to develop frame sufficiently road to include the different cause maps and sources of knowledge, inhibiting intra-organizational learning. Moreover, when people fail to speak their minds

freely, may cause risk-taking behaviors, overconfidence and complacency, which result in inaction (Weick et al., 1999; Whyte, 1998; Zhang et al., 2018).

Estimates regarding the relationship between cross-agency boundary-spanning and adaptation seem to corroborate the notion that external organizations, familiar to agency decision-makers, can function as boundary-objects. Actors may use peers' experiences in conversations as tangible metaphors and shared reference points to facilitate consensus development and action-taking within the agency (Majchrzak et al., 2012; Star & Griesemer, 1989). Cross-agency boundary-spanning activities have also the potential to facilitate vicarious learning. By providing decision-makers with clear examples of best practices and pitfalls, these activities ultimately aid in learning and adaptation, regardless of individuals' own interpretations of the risks posed by extreme weather (Doberstein, 2016; Häußler & Haupt, 2021).

Taken together, these findings contribute to climate-change adaptation scholarship in different ways. While extant literature discusses adaptation to extreme weather and climate change in terms of organizational learning, it predominantly focuses on exogenous determinants such as crises or past experiences, and structural elements like financial capacity that facilitate adaptation. However, learning and adaptation are outcomes of internal decision-making processes, the dynamics and unfolding of which must be comprehended thoroughly to effectively promote informed action. Hence, I contribute to the extent literature by examining how internal dynamics may shape adaptation.

Integrating Daft and Weick three stages framework with organizational learning literature, findings underscore that learning and action-taking result from processes through which agencies develop collective interpretations of the environment, and highlight the importance of conversations within the organization. That is, symbolic, cognitive, and discursive elements play pivotal roles in shaping how organizations construct shared cause maps of their external environment. As suggested by Daft and Weick "the distinctive feature ... is sharing. […] Passing a startling observation among members, or discussing a puzzling development enables managers to converge on an approximate interpretation" (Daft & Weick, 1984, p. 285), leading to consensus development and organizational action (Crossan et al., 1999; Fiol, 1994).

Drawing on Fiol (1994) and Donnellon and colleagues (1986) work, I also extend organizational integrative scholarship examining how decision-making processes regarding future events, distinguishing between two distinct mechanisms of organizational integration and consensus development, consensus on cause maps' content and consensus around cause maps' framing. Consensus on content emerges when members share a common perception of the elements shaping their external environment. This facilitates mutual understanding, enabling sensemaking processes that can lead to organizational actions. To this extent, findings show that when multiple perceptions of the external environment exist within the organization, content heterogeneity is associated with lower adaptive probabilities. Consensus around framing, instead, entails presenting issues or threats broadly enough so that behavioral implications are similar across members regardless on their perception and interpretation of the external context.

Hence, findings show that processes that facilitate the development of shared frames are more likely to promote learning and action-taking.

While asserting the independence of framing and content aligns with existing interpretative theories, it is plausible that these two processes are intertwined. I explored this possibility by introducing interaction terms between content and framing variables (e.g., risk perception heterogeneity and debative cooperation) into the model but found non-statistically significant results. Although these empirical findings lend support to the idea of distinctiveness, it is important to recognize that methodologically, binomial regressions are "inherently interactive" (Long, 1997). Therefore, coefficients and the significance of product terms in binomial regression models may not offer unbiased insights into the direction, magnitude, or significance of the interactions (Long, 1997). Furthermore, the non-significance of the coefficients may also be attributed to the limited statistical power resulting from the small number of observations included in the analysis. Future research could further explore the possibility of interactions between content and framing testing them using non-categorical data and larger sample sizes (Long, 1997).

Finally, while integrative studies typically examine internal organizational processes, this study, drawing on Daft and Weick idea of organizations as open interpretative systems, show that a thorough understanding of the processes conducive to consensus development and action-taking should also consider organization's relationships with their operational domain. To this extent, cross-agency boundary-spanning activities appear to favor shared framings and, consequently, adaptation.

Results have implications for practice. Consistent with Daft and Weick (1984) and Crossan and colleagues' (1999), findings suggest that public agencies seeking improved adaptation to extreme weather events should prioritize two strategies. First, organizations should aim to develop homogeneous perceptions of the risks faced. One way to achieve this goal may stem from investing in socialization processes designed to align members' perspectives (Saks & Ashforth, 1997). Future studies should, however, further explore the feasibility and effectiveness of this solution.

Second, agencies should establish processes that promote open and transparent communication, both internally among team members and with external stakeholders. Engaging in debative cooperation facilitates the framing of issues broadly enabling consensus development among decision-makers with differing perceptions of risk, ultimately resulting in adaptation. In contrast, avoiding discussions may lead to faulty mental models and, thus, impede learning and action.

In summary, this study underscores the importance of nurturing shared perceptions, promoting transparent communication, and engaging with external stakeholders as essential components of an organization's resilience when facing extreme weather events. These strategies not only enhance internal cohesion but also enable the organization to tap into external expertise and facilitate the spread of effective approaches.

Conclusion

Climate change, the effects of which we have only just begun to witness, is the greatest threat humanity is facing (UN, 2021). In the US alone, July 2023 was the worst

month on record for natural disasters resulting in fatalities, economic damages, and devastation (NOAA, 2023). Challenged by extreme weather events that are becoming extremely threatening, public agencies are under increasing pressure to adapt to them (Ekstrom & Moser, 2014; Miao et al., 2018). In this context, this study finds that fostering a common interpretation of the risks at hand, debative cooperation, and establishing cross-agency boundary-spanning activities in responding to climate threats, can promote unity of purpose within the organization, streamline adaptive initiatives, and facilitate the timely and efficient implementation of necessary changes.

CHAPTER 5

CONCLUSION

The frequency of the word "risk" appearing on the New York Times front page has sharply increased over the past few years, growing 45% between 1999 and 2023[11]. Although anecdotal, this figure underscores the prominence of discussions surrounding "potential losses" in everyday conversations – a trend anticipated to intensify as threats become more widespread in modern society, spanning various domains from economy to health, from geopolitics to technology (Beck, 1992; Tierney, 2014).

To manage and navigate these risks, societies are increasingly relying on public agencies (Boin & van Eeten, 2013; Roberts, 2020). Agencies, in turn, invest extensively in developing and implementing highly technical approaches such as risk mapping and forecasting tools (Bierbaum et al., 2013). Yet, recent phenomena, such as the floods which devasted North-East US throughout the 2023 summer and fall, showed that regardless of the technical solutions we put in place, we keep grappling to effectively manage risk (Flavelle & Rojas, 2023; Tierney, 2014). These failures puzzle citizens, practitioners, and scholars, prompting questions on why, with such significant technological capabilities, we still struggle to manage risks effectively (Tierney, 2014). This dissertation answers this question, positing that what is missing is an analysis of risks as socially constructed phenomena.

[11] I computed the figure using the New York Times APIs. I counted the occurrences of the word "risk" on the newspaper's front page from 1999 to 2023. Despite some exceptions (e.g., 2020), the growth has been consistent.

Conceptualizing risks as stemming from social elements shows that all those crises and disasters, too often considered as one-off occurrences, share similar root causes (Tierney, 2014). Moreover, uncovering risks' social roots empowers public agencies and reinstates agency within them, enabling a more systematic approach to adaptation, and reducing organizational over-reliance on ad-hoc procedures (Zhang & Welch, 2022). Ultimately, this enhanced social awareness could complement the technical tools in place, providing public agencies with knowledge they can articulate to better adapt to the challenges ahead. As a result, the dissertation answers the following research questions: *how public organizations interpret and respond to the threats they face? Which elements determine agencies' perceptions of the environment? How do public agencies cultivate a shared perception of extreme weather events risks? Why are some organizations more likely to learn and adapt to extreme weather events? What is the role played by internal processes in fostering or preventing adaptation from occurring?*

I examine public organizations as open interpretative systems, and adapt the framework theorized by Daft and Weick (1984). Consistent with this approach, I posit that public agencies are interdependent with the contexts in which they operate and address risks' uncertainty and ambiguity by collecting, processing, and making sense of information from their external environment (Daft & Lengel, 1986; Walsh & Ungson, 1991). This process, which spans across different levels (i.e., individuals, groups, and organizations), is shaped by actors' interactions, cognitive diversity, and power dynamics, and unfolds across three stages: data collection, interpretation, and action-

taking (Crossan et al., 1999; Daft & Huber, 1986; Daft & Weick, 1984; Hambrick & Mason, 1984).

During the **data collection** stage organizations scan their operating context and collect information to make sense of it (Daft & Weick, 1984). Subsequently, in the **interpretation** stage, collected data are given meaning as agencies develop shared understandings of the external environment (Daft & Weick, 1984). Once shared interpretations are developed, organizations **take action** to respond to the threats they face (Crossan et al., 1999; Fiol, 1994).

Progressing through the stages of the interpretative framework, the three studies of this dissertation build on each other to investigate how public organizations interpret and prepare for the risks posed by extreme events. Each study examines one of the three stages, focusing on US public transit agencies. Specifically, they analyze how public organizations make sense of and adapt to the threats posed by extreme weather phenomena, one of the "biggest challenges modern humans have ever faced" (UN, 2021).

The first study of the dissertation focuses on the **data collection** stage. The study examines how information collected from the operational domain helps address the ambiguity and uncertainty characterizing extreme weather events and determines agencies' risk perceptions of these phenomena (Daft & Weick, 1984). Drawing on the information processing theory (Daft & Lengel, 1986; Galbraith, 1974), I examine the social root causes that could lead to maladaptation to the risks faced and answer the following research question: *How do scientific information and contracting influence public transit agency perceptions of extreme weather risk?* I focus on scientific

information and contracting as IPT identifies both these elements as pivotal in making sense of the external environment. I develop and test hypotheses integrating data coming from a 2019 national survey of US transit agencies and the National Transit Database (NTD) data on contracting and running a mediation model.

Findings suggest that the type of information agencies use to interpret extreme weather events shapes organizational risk perceptions by impacting agency cognitive capacity and addressing ambiguity and uncertainty. For instance, relying on scientific information fosters critical thinking and evidence-based decisions. It also reduces both the uncertainty and ambiguity agencies face, as it offers reliable information and models to show the effects of extreme weather on the organization.

In addition to extending IPT to public sector organizations dealing with extreme weather phenomena, results also reveal the existence of multiple risk perceptions within the agency. However, since perceptions and cognitive divergencies among actors represent one of the barriers to adaptation most cited in the literature (Moser & Ekstrom, 2010), findings also raise questions on how public agencies can overcome these discrepancies. As a result, the second study integrates the first one, looks at the **interpretation** stage, and answers the following research question: *How do agencies develop organizational interpretations of the risks posed by extreme weather events?*

An analysis of semi-structured interviews with public managers employed at four different transit agencies reveals that the characteristics of the actors involved in the interpretative process influence its unfolding. In particular, the roles and the resources of decision-makers shape the mechanisms put in place to address heterogeneous

interpretations. That is, the development of organizational shared meanings entails organizational political practices through which actors advocate for particular interpretations of the risks posed by extreme weather phenomena.

The study identifies three processes through which organizational interpretations can be developed: conversation, suppression, and shared experience. Conversation involves the use of communication tools to construct intersubjective meanings. Suppression occurs when top managers impose their interpretation of extreme weather events on the rest of the organization. Shared experiences entail providing managers with opportunities to undergo the same experiences, facilitating the development of shared interpretations of the operational context.

Informed by the findings of the previous studies, the third one draws on both organizational learning and interpretative scholarship to examine the **action-taking** stage and analyze the effectiveness of alternative decision-making processes in facilitating or hindering adaptation to extreme weather phenomena. Hence, it answers the following research questions: *Why are some organizations more likely to learn and adapt to extreme weather events? What is the role played by internal processes in fostering or preventing adaptation from occurring?*

The analysis of survey data informed by interviews and administered to US public transit agencies in 2023, validates results from the first study and shows that while some agencies share almost identical risk perceptions, others do not. Furthermore, expanding upon the findings of the first research, I find higher levels of risk perception heterogeneity to be a barrier to decision-making and the undertaking of adaptive actions.

Findings also suggest that two distinct strategies enable organizational adaptation to extreme weather events. The first one consists in framing the threats posed by extreme phenomena broadly enough so that discrepant interpretations lead to similar behavioral responses. The second one entails fostering identical interpretations of the external environment among organizational actors. Specifically, results show that internal discussions and engagement with external stakeholders contribute to the development of shared framings of extreme weather risks, facilitating adaptation even when agencies are characterized by high levels of risk perception heterogeneity (Cornelissen & Werner, 2014; Donnellon et al., 1986; Schmickl & Kieser, 2008; Weick, 1969).

Limitations

The three studies acknowledge and address specific limitations within their scope. However, there are some broader constraints common among them, which I will discuss here. In particular, the dissertation's focus on transit agencies as well as on extreme weather events may restrict the generalizability of its findings.

While public transit agencies are an ideal subsector for examining the unfolding of the interpretative process for several reasons (see Introduction), those same characteristics that make them suitable for this study may limit the validity of the results to the transportation sector. This limitation is especially relevant considering the operational and technical complexity which characterizes transit agencies and sets them apart from other public organizations.

Operationally, transit agencies must oversee a diverse array of service modes, ensuring that routes, schedules, and complementary services like paratransit offerings are

synchronized to meet the dynamic needs of the public. Moreover, agencies often operate within broader transportation networks that span multiple jurisdictions, necessitating to coordinate their activities with various entities such as departments of transportation, municipal governments, and regional planning organizations. Technically, they rely on sophisticated, tightly-coupled, equipment, infrastructures, and information technology solutions, all of which demand specialized knowledge and expertise.

While the complexity and the distinct nature of transit agencies may affect the generalizability of the dissertation, some factors should be considered to partially mitigate these concerns. First, transit agencies are not the sole complex organizations within the public sector. Other agencies managing critical infrastructures and sophisticated technologies – such as electricity grids, water distribution, airport administrations, or waste management – deal with comparable levels of complexity and are equally vulnerable to extreme weather events. Consequently, while my findings may not universally apply to all public agencies, they can still inform and be relevant to interpretive studies in similar organizational contexts.

Second, the phenomena studied here are common across most, if not all, organizations. The interpretative framework, at its core, revolves around decision-making, learning, and sense-making of the external environment, three processes that are inherent to all organizations, not just transit agencies. Therefore, it is reasonable to expect that the insights gained from this analysis could be applicable in various domains.

Finally, from a research design perspective, the geographic dispersion of the analyzed agencies, the diversity of the populations they serve, and the variability in the

types of extreme phenomena experienced suggest that my findings may have relevance across various contexts.

With regards to the types of phenomena examined, the environmental nature of extreme weather events has some peculiarities that differentiate them from other risks, such as financial or technological ones. For example, as further discussed below, technological risks, unlike extreme weather phenomena, are often endogenous to the organization and require different interpretative solutions and processes (e.g., Weick et al., 1999). Hence, the findings of the dissertation may be less applicable to threats non-environmental in nature. Nonetheless, it is worth mentioning that dissertation draws on broad organizational theories that have been validated in diverse settings, suggesting their potential applicability to examine threats different than extreme weather.

Contribution to theory

The dissertation contributes to both public management and organizational scholarship. It advances public management scholarship by focusing on how public sector organizations interpret risks. Despite the crucial role public agencies play in managing risks across various domains, literature on how these organizations interpret, manage, and prepare for the challenges they face remains scant at best (Bullock et al., 2019). Existing studies on risk often center on individuals or systems (e.g., Perrow, 1994; Roberts & Wernstedt, 2019; Tangsgaard, 2021), with less research examining organizations (Gould, 2021). Yet, organizations are much more effective than single individuals or systems in managing threats (Gephart et al., 2009; Scott & Davis, 2007). Consequently, scholars have underscored the need for more theoretically informed

research on risk management in the public sector (’t Hart, 2013; Boin & Lodge, 2016; Bullock et al., 2019). By investigating the processes through which public sector entities make sense and respond to threats, this dissertation answers these calls and provides theoretical insights on the mechanisms through which it is possible for public agencies to adapt to the risks they face.

A second contribution to the public management scholarship stems from studying extreme weather events. Much of the extant literature is focused on technological risks and disasters with less research analyzing environmental threats. For example, several studies draw on Perrow’s Normal Accident Theory (1984) and on the High Reliability Theory to investigate accidents in nuclear power plants, airport securities, or electric power distributions (Frederickson & LaPorte, 2002; LaPorte, 1996; LaPorte & Consolini, 1991). Less research, instead, theorizes on risks related to extreme weather events, even though environmental and technological risks differ in three main aspects.

First, the technological risks studied are low frequency-high severity phenomena, while extreme weather events vary regarding their frequency, magnitude, and raise of onset (Zhang, 2022). Second, environmental risks usually stem from lack of control, while technological risks result from loss of control. Third, technological risks are usually caused by human (in)actions like poor designs, lack of maintenance, and absence of internal communication. Environmental risks, instead, are usually the result of natural processes (Prasad & Francescutti, 2017).

By looking at threats exogenous to the organization the dissertation enriches existing public and risk management scholarship by offering a nuanced understanding of how public agencies navigate threats originating from the context in which they operate.

Third, the dissertation contributes to public management scholarship by examining how cognitive diversity impacts organizations' decision-making processes. While literature extensively explores how heterogeneity in employee demographic composition influences agency performance (Ding & Riccucci, 2022; Sabharwal, 2014; Sabharwal et al., 2018), diversity encompasses more than just differences in race and gender (Harrison & Klein, 2007). As stated by Sabharwal and colleagues, citing Thomas (1990), "managing for diversity means managing for all differences" (2018, p. 251). Among these differences, task-related ones, stemming from cognitive heterogeneity are particularly relevant, as they shape organizational functioning (Harrison & Klein, 2007; March & Simon, 1993; Olson et al., 2007). Hence, by examining how discrepant cognitive and interpretative perspectives influence the undertaking of adaptive actions, the dissertation provides an enriched theoretical understanding of public agencies decision-making processes, highlighting the role of discursive practices in facilitating action-taking.

The dissertation contributes to existing organizational and risk scholarship by conducting a thorough analysis of the antecedents, consequences, and factors influencing the interpretative process through which agencies make sense of current and future threats. As discussed in the second study, literature extensively focuses on retrospective interpretative processes organizations put in place following the occurrence low-

probability, high-impact disasters, as these events are typically well-documented and easy to reconstruct (Maitlis & Christianson, 2014; Sandberg & Tsoukas, 2015). Less research, instead, studies the formation of organizational interpretative processes aimed at informing actions addressing present and future threats, even though understanding these phenomena may facilitate organizational change and survival (Gephart et al., 2010; Kaplan & Orlikowski, 2013). The dissertation addresses this gap in knowledge and extends interpretative scholarship, connecting it with organizational learning and decision-making domains, and laying the groundwork for further theoretical integration between organizational and risk management scholarship.

Finally, the study contributes to adaptation literature by studying organizations as non-unitary actors. While much of the adaptive scholarship, following Berkhout's seminal paper (2012), studies organizations as entities characterized by a singular set of views and approaches, this approach may oversimplify the complexities inherent organizational adaptation. Organizations are not monolithic entities, particularly when they comprise highly qualified, staff working in goal-oriented contexts (Yi-Chong & Weller, 2008). Moreover, treating organizations as unitary systems shifts focus away from understanding and addressing socio-cognitive barriers to adaptation and over-emphasizes tangible barriers related to resources (financial, technological, and physical). To this extent, the IPCC's reviews of barriers to climate change adaptation underscore the limited attention given to social elements in shaping adaptive actions (Adger et al., 2007). By delving into and theorizing these aspects, the dissertation identifies the elements and social processes that facilitate improved interpretations of the risks characterizing their

operational context. Additionally, it provides an enhanced understanding of the mechanisms that enable agencies to overcome cognitive discrepancies, which frequently impede adaptation efforts (Moser & Ekstrom, 2010).

Contribution to practice

In addition to theory, the dissertation makes practical contributions in different ways. First it re-establishes the social dimension of risk as a critical element in organizational discourse. Following the New Public Management reforms, agencies have started thinking of and dealing with risk from a technical perspective, delegating the related planning activities to third parties, without being actively involved in the process (Carlsson-Wall et al., 2018). This has brought to a formalization of risk management practices, through the creation of functions and tools aimed at providing technical assessments of the challenges faced. (Palermo, 2014). However, these practices have turned risk management into an assurance practice with a focus on documentation rather than a solution enabling action-taking (Carlsson-Wall et al., 2018). By emphasizing the pivotal role of risk interpretations in enabling action, the dissertation offers valuable insights for practitioners, urging them to manage risks keeping into account both social and technical elements. Recognizing and integrating the social dimension of risk into practice can enrich risk management strategies making them not only technically robust but also aligned with the complexities of organizational life.

The dissertation underscores the importance for organizations to invest in the development of cognitive capabilities. As shown by the first study, these resources support agencies in navigating the inherent ambiguity and uncertainty of the external

environment. Cognitive capabilities, in other words, can enhance an agency information processing capacity and facilitate more effective actions (Galbraith, 1974). Conversely, their absence or reduction can lead to humanitarian and infrastructural disasters, by preventing an accurate interpretation of the threats posed by the external environment (Comfort, 2007). As a result, findings warn public managers against extensive outsourcing strategies, which may result in the loss of expertise, hinder the agency's understanding of the environment, and weaken organizational adaptation to extreme phenomena.

The dissertation suggests that public agencies seeking improved adaptation to extreme weather events should establish processes that promote open and transparent communication, both internally among team members and with external stakeholders. Engaging in conversations facilitates the framing of issues broadly enabling consensus development among decision-makers with differing perceptions of risk, ultimately resulting in adaptation. In contrast, avoiding discussions may lead to faulty mental models and, thus, impede learning and action. By elucidating the operational mechanics of these elements, the study informs organizations that aim to adapt to and navigate the challenges posed by extreme weather.

Taken together, insights from the dissertation provide practitioners with a better understanding of the elements and the processes associated with organizational risk perceptions. Findings inform public managers on how to implement tailored interventions to promote more effective risk management practices across the organization. In other words, knowing the antecedents, the consequences, and the mechanisms through which

the interpretative process unfolds could help decision-makers to enhance agencies' resilience, overcome the challenges posed by climate change, and minimize the risks our societies are facing.

Moving forward: Questions to be answered

The dissertation offers initial insights into the interpretative process and its role in facilitating adaptation to extreme weather events, yet some questions remain unanswered, indicating directions for future investigation. First, the role of "feedback loops" should be further examined. As suggested by Daft and Weick (1984), the action-taking stage supplies agencies with new data, informing subsequent interpretative processes. Despite efforts to consider the impact of past experiences on decision-making, the cross-sectional nature of the data used for the dissertation limited my ability to model the "loop" characterizing the interpretative process. Consequently, future research should investigate more in detail the unfolding of this feedback, particularly examining how past adaptive projects influence new interpretative mechanisms. One approach could involve developing a panel dataset by integrating FEMA's national risk index, released annually since 2022, with NTD administrative data on agencies' spending. The resulting dataset, combined with a multi-wave survey, could illuminate the dynamics of the feedback loop.

Related to the previous point is the recognition that the interpretative process is a continuous ongoing process through which organizations translate events and develop frameworks for understanding (Daft & Weick, 1984; Isabella, 1990). While the three studies provide a snapshot of this process, they do not examine the evolution of

interpretative frameworks over time. Hence, future research should investigate how these frameworks evolve and unfold in response to changing circumstances.

Third, the dissertation examines the three phases of the interpretative process individually. However, in reality, these stages are interconnected and often occur simultaneously as agencies navigate their operating environment. Therefore, future research should aim to undertake a more holistic examination of their unfolding. This approach would explore how the different stages interact with each other influencing the decision-making process. For example, it would be interesting to investigate whether different data collection strategies correlate with specific approaches to reconciling disparate environmental interpretations, and how these strategies either facilitate or hinder the development of consensus.

It will also be important to build on the insights gained from interviews with transit managers, which suggest that middle managers do contribute to the interpretative process. Specifically, research should further examine their role and the extent to which they influence organizational adaptation. Unfortunately, due to the unavailability of contact information for middle managers, I couldn't gather data from them. However, future studies could potentially prioritize internal validity over external validity by collaborating with a large transit agency. This partnership could facilitate the administration of a survey to the entire organization, providing a comprehensive examination of the role of middle managers in the interpretative process.

Finally, the dissertation leaves open questions on whether the interpretative process leads to the undertaking of **adequate** adaptive practices and eventually under

which conditions different interpretative processes are more effective to ensure a proper minimization of the threats faced by public agencies. Understanding these contingencies will improve our theoretical and empirical understanding on how interpretative and decision-making processes can enable adaptation to extreme weather phenomena.

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APPENDIX A

DESCRIPTION OF AGENCIES' SELECTION CRITERIA

To identify organizations to interview I adopted a combination of theory-based and maximum variation sampling (George & Bennett, 2005). Drawing on organizational interpretative scholarship, I focused on complex agencies with prior experience in extreme weather events, as they are likely to exhibit diverse interpretations of the challenges posed by these phenomena. From this pool of agencies, I identified and selected organizations that varied in the types and frequency of experienced weather events. This approach aimed to uncover and describe common patterns across different contexts (Marshall & Rossman, 2016; Miles et al., 2020).

I selected agencies to interview based on three main criteria. First, agencies needed to exhibit sufficient complexity, as interpretations' heterogeneity tends to arise in large organizations characterized by task division and complexity (March & Simon, 1993). I measure organizational complexity by looking at two elements specific to transit agencies: the total population served and the number of vehicles they directly operate. Both these two variables were provided by the National Transit Database (NTD). A higher number of directly operated vehicles indicates greater task division, as agencies strive to maximize economies of scale and scope, and increased task complexity due to potential failures across multiple technologies. Similarly, serving a larger population adds to task complexity as larger populations have a greater variety of needs and requirements that agencies need to satisfy (Hefetz & Warner, 2004). Hence, the agencies selected for interviews were chosen from those directly operating more vehicles than the median number within the entire population of transit agencies and serving a population larger than the median served by other transit agencies.

APPENDIX B

RECRUITMENT EMAIL SENT TO TRANSIT MANAGERS

Dear [Name Last Name],

We are conducting our third national study to understand how transit agencies are coping with and responding to extreme weather events. Our previous studies were conducted in 2019 and 2016.

We are contacting you because of your managerial role and your firsthand experience with the impacts of extreme weather on your agency. We know you are very busy and value your time. Your insights will help us better understand the impact extreme weather can have on agencies' ability to provide public services.

We would like to speak with you for about 45 minutes over Zoom at a time that is convenient for you. There is no need for you to prepare as the topics concern your normal managerial activities. The interviews are confidential and all data will only be reported as aggregated findings or as de-identified inputs in reports and manuscripts.

Please let us know if you would be willing to participate in the study. We will get back to you to arrange a time that works for you. Additionally, if there is anyone else at your agency that you think it would be helpful for us to talk to, we would welcome any of your recommendations.

Sincerely,

Eric Welch
Professor
Affiliate Sustainable Transportation and Urban Futures Initiative
Arizona State University

Mattia Caldarulo
Research Associate
Center for Science, Technology and Environmental Policy Studies
Arizona State University

APPENDIX C

INTERVIEW PROTOCOL

Heterogenous perceptions of risk in transit agencies: Interview protocol

Thanks a lot for agreeing to talk with me. I am Mattia Caldarulo, a doctoral candidate at the School of Public Affairs at ASU. As part of my dissertation, I am examining how public organizations plan for and adapt to climate-driven phenomena like extreme weather events. By 'extreme weather events' I mean climate occurrences that are more severe, inconsistent, and damaging than what has been observed historically, like freezing events, floodings, wildfires, or hurricanes.

I am particularly interested in studying the decision-making processes of complex organizations like transit agencies, which not only have to effectively provide public services but also have to guarantee users' and operators' safety. For this reason, I am conducting some interviews across different transit agencies in the US.

1. **Introductory questions**
   a. To get us started, could you briefly describe your job and your agency?
      i. What responsibilities do you have? How large is your department? Which duties does it have?
      ii. How would you describe the organizational culture in your agency? For example, would you say people in your agency are results-oriented? Are they team-oriented? Are they friendly and easy to collaborate with?

2. **Past extreme weather events**
   a. I would like to transition to the main topic of the interview: extreme weather events. In the past few years, your agency has experienced different types of extreme weather events. For example, [*in 20XX you had to deal with*]. Thinking about past events experienced by your agency, which impacts have they had on your agency?
      i. For example, did they harm any operator, driver, or passengers? Did they damage any of the agency's assets? Did they cause service disruptions?

3. **Decision-making to adapt to extreme weather ~~events~~**
   a. Could you describe the decision-making process your agency usually follows to adapt to extreme weather events?
      i. Are these decisions discussed during ordinary management meetings?
      ii. What are these discussions about? How frequent are these discussions?
      iii. Who or which departments take part in these discussions? Are external actors like citizens or other organizations involved in these discussions?
   b. Could you describe the climate of these discussions? Do people share similar perspectives about these events?
      i. [*If disagreement exists within the agency*] How are divergences settled down?

ii. [*If disagreement does not exist within the agency*] How do you manage to make sure you are all on the same page?
iii. How influenced are these decisions by past experiences?
iv. Would you consider these meetings as part of a routine?

4. **Other risks faced by the agency**
    a. In addition to extreme weather events, which other risks challenge your organization?
        i. What is their nature? Are they caused by humans, are they environmental, are they technological?
        ii. Are there some risks your organization pays more attention to? Why?

    b. Do the decision-making processes used to address extreme weather events differ from the ones used to address other challenges?
        i. In which aspects to these processes differ? Why?
        ii. For instance, are decision-making processes dealing with extreme weather events more hierarchical and centralized? Can you provide some examples?
        iii. Are the actors involved in the processes the same? Why?

5. **Conclusion**
    a. Thank you so much for your time and consideration! As I mentioned at the beginning of our chat, my interest is in understanding how organizations decide how to respond to extreme weather events. Is there anything else you want to say that would me help understanding these organizational processes?

    b. [*Asked to senior managers*] I would be interested in speaking to some people you supervise about the decision-making process characterizing your agency's approach towards extreme weather events hazards. Would it be possible for you to introduce me to them?

APPENDIX D

CFA OF THE ITEMS UNDERLYING THE KEY DEPENDENT VARIABLE

Table 19: Confirmatory Factor Analysis of the items underlying the key dependent variable

Items	*Std. Estimate*	*T-Statistics*	*P-Value*
Implemented green infrastructure projects to help reduce flooding and manage stormwater	0.69	4.30	0.00
Adopted stricter construction and engineering standards to address extreme weather	0.60	4.42	0.00
Required suppliers to make equipment or vehicle improvements to address extreme weather	0.62	4.34	0.00
Installed new weather warning systems	0.62	4.20	0.00
Set aside new funds dedicated for extreme weather events	0.60	4.64	0.00
Submitted a grant application for projects to minimize weather impacts	0.60	4.56	0.00
Conducted data analytics or business intelligence to identify areas for improvement to address extreme weather	0.90	1.81	0.07
Invested in new weather-smart equipment and technologies	0.65	4.17	0.00

APPENDIX E
HECKMAN SELECTION MODEL

Table 20: Heckman selection model estimates

	Outcome Model			
	Model 1		Model 2	
Parameters	Est.	Std. Err.	Est.	Std. Err.
Independent Variables				
Risk perception heterogeneity	-0.056	0.048	-0.055	0.045
Cross-functional activities	-0.119	0.095	-0.125	0.089
Debative cooperation	-0.004	0.098	-	-
Debate avoidance	-	-	-0.164	0.110
Cross-Agency Boundary-span	**0.308*** **	0.096	**0.290*** **	0.096
Control Variables				
Extreme Weather Frequency	-0.030	0.070	0.106	0.514
Extreme Weather Severity (ln)	0.013	0.015	0.044	0.109
Extreme Weather Impact	0.000	0.109	0.028	0.108
Density (ln)	0.134	0.192	0.325	0.877
Region: South	**-0.362** **	0.162	**-0.381*** **	0.146
Region: West	-0.174	0.162	-0.175	0.173
Region: North-East	-0.209	0.168	-0.236	0.161
Mode: Bus	-0.225	0.214	-0.277	0.210
Mode: Light Rail	0.058	0.129	0.008	0.086
Centralization	-0.043	0.197	0.023	0.105
VOMS (ln)	**0.076** **	0.026	**0.057** **	0.025
Political Influence	**-0.129***	0.073	**-0.136***	0.069
Stakeholders influence	0.034	0.077	0.055	0.065
Intercept	0.359	1.535	1.292	3.733
	Selection Model			
	Model 1		Model 2	
Parameters	Est.	Std. Err.	Est.	Std. Err.
Extreme Weather Frequency	-0.076	0.117	-0.076	0.117
Extreme Weather Severity (ln)	-0.016	0.027	-0.016	0.027
Density (ln)	-0.136	0.229	-0.136	0.229
VOMS (ln)	0.025	0.081	0.025	0.081
Intercept	1.197	1.771	1.197	1.771
Inverse Mills Ratio	-2.066	7.441	-2.972	10.032
N	211		211	
Selected (non-selected)	106 (105)		106 (105)	

* p<0.1, ** p<0.05, *** p<0.01,
Standardized Coefficients,
Reference Categories: Region Midwest and Service Heavy Rail

APPENDIX F

REDUCED MODELS

Table 21: Reduced models estimates

	Model 1		Model 2	
Parameters	Est.	Std. Err.	Est.	Std. Err.
Independent Variables				
Risk perception heterogeneity	**-0.47***	0.28	**-0.46***	0.27
Cross-functional activities	-0.73	0.52	-0.57	0.50
Debative cooperation	**0.95***	0.56	-	-
Debate avoidance	-	-	**-1.20****	0.61
Cross-Agency Boundary-span	**1.78*****	0.58	**1.69*****	0.58
Control Variables				
Extreme Weather Frequency	**0.68***	0.38	**0.66***	0.39
Extreme Weather Severity (ln)	**-0.18****	0.08	**-0.16****	0.08
Extreme Weather Impact	**1.97****	0.99	**2.01****	1.03
Mode: Light Rail	**-1.36****	0.68	**-1.57****	0.70
VOMS (ln)	0.17	0.13	0.13	0.13
Stakeholders influence	**1.00***	0.53	**1.14****	0.55
Intercept	-3.31	2.87	2.62	2.88
N	104		104	
Nagelkerke R2	0.27		0.28	

* p<0.1, ** p<0.05, *** p<0.01,
Standardized Coefficients,
Reference Categories: Region Midwest and Service Heavy Rail
AME: Average Marginal Effects

APPENDIX G

PENALIZED MAXIMUM LIKELIHOOD ESTIMATION (PMLE)

Table 22: Models predicting adaptation adjusted for Firth method

	Model 1		Model 2	
Parameters	Est.	Std. Err.	Est.	Std. Err.
Independent Variables				
Risk perception heterogeneity	**-0.47***	0.24	**-0.45***	0.24
Cross-functional activities	-0.68	0.49	-0.37	0.44
Debative cooperation	**0.90***	0.50		
Debate avoidance			**-1.06***	0.58
Cross-Agency Boundary-span	**1.45*****	0.52	**1.47*****	0.53
Control Variables				
Extreme Weather Frequency	**0.76***	0.37	**0.66***	0.38
Extreme Weather Severity (ln)	-0.13	0.08	-0.12	0.07
Extreme Weather Impact	**1.58***	0.86	**1.69***	0.89
Density (ln)	0.19	0.91	0.24	0.87
Region: South	0.36	0.75	0.30	0.74
Region: West	0.72	0.94	0.63	0.92
Region: North-East	-1.03	0.85	-0.74	0.85
Mode: Bus	0.03	1.08	-0.03	1.08
Mode: Light Rail	**-1.29***	0.72	**-1.50***	0.75
Centralization	0.08	0.55	0.42	0.58
VOMS (ln)	0.19	0.13	0.16	0.13
Political influence	0.04	0.44	-0.15	0.45
Stakeholders influence	0.42	0.54	0.64	0.55
Intercept	-4.65	7.52	-0.53	7.14
N	104		104	
Nagelkerke R2	0.27		0.28	

* p<0.1, ** p<0.05, *** p<0.01,
Standardized Coefficients,
Reference Categories: Region Midwest and Service Heavy Rail
AME: Average Marginal Effects

APPENDIX H

IRB APPROVAL FOR INTERVIEWS

ASU Knowledge Enterprise Development

APPROVAL: MODIFICATION

Eric Welch
WATTS-PA: Science, Technology and Environmental Policy Studies, Center for (C-STEPS)
-
EricWelch@asu.edu

Dear Eric Welch:

On 12/8/2022 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	US Transit Agency Adaptation to Extreme Weather Events
Investigator:	Eric Welch
IRB ID:	STUDY00003589
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• HRP 503a_2021update, Category: IRB Protocol; • Interview consent form, Category: Consent Form; • Interviews_Protocol_Final.pdf, Category: Recruitment materials/advertisements /verbal scripts/phone scripts; • Recruiting material final, Category: Recruitment Materials;

The IRB approved the modification.

When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

APPENDIX I

IRB APPROVAL FOR 2023 SURVEY

ASU Knowledge Enterprise Development

APPROVAL: MODIFICATION

Eric Welch
WATTS-PA: Science, Technology and Environmental Policy Studies, Center for (C-STEPS)
-
EricWelch@asu.edu

Dear Eric Welch:

On 3/28/2023 the ASU IRB reviewed the following protocol:

Type of Review:	Modification / Update
Title:	US Transit Agency Adaptation to Extreme Weather Events
Investigator:	Eric Welch
IRB ID:	STUDY00003589
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• HRP 503a_2023_update, Category: IRB Protocol; • Recruiting_Material_Alert_23, Category: Recruitment Materials; • Recruiting_Material_Invite_23, Category: Recruitment Materials; • Survey Instrument Updated_23, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Transit_Consent_23, Category: Consent Form;

The IRB approved the modification.

When consent is appropriate, you must use final, watermarked versions available under the "Documents" tab in ERA-IRB.

In conducting this protocol you are required to follow the requirements listed in the INVESTIGATOR MANUAL (HRP-103).

Sincerely,

IRB Administrator

cc: Lesley Michalegko
Leonor Camarena
Ashlee Frandell
Shaika Lamia Islam
Ignacio Carlos Pezo Salazar
Hey Jie Jung
Elizabeth Corley
Lesley Michalegko
Eric Welch
Mattia Caldarulo
Tianyi Xiang
Fengxiu Zhang
Jared Olsen
Suyang Yu

APPENDIX J

PREVIOUSLY PUBLISHED STUDY

In March 2023, Chapter 2 titled “The Data Collection Stage” from the dissertation has been published in Public Management Review.