

ARTICLES

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THE MULTILEVEL PATH TO CLIMATE CHANGE ADAPTATION

O caminho multinível para adaptação às mudanças climáticas

El camino multinivel hacia la adaptación al cambio climático

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ABSTRACT

Climate change is a much neglected but urgent matter for society. Frequent and extreme weather events, fires, rising sea levels, and other such events are just some of the expected effects for which organizations must prepare and adapt. This article presents a systematic literature review on climate change adaptation and analyzes the factors that influence organizations' strategic decision-making. The findings lead to a model elaborated to explain the role of such factors, considering their level of influence – individual, organizational, and institutional. This study contributes to the literature by proposing a model of climate change adaptation and explains the relationship between the internal and external factors in a multilevel context. The model identifies risk perception as one of the main contingent factors in adapting to climate change. Other contingent factors are the organizational resources and capabilities, stakeholders, and partnerships. Finally, the study demonstrates that public policies, values, individual experience, and cognitive capacity are important antecedents in the adaptation process.

Keywords: adaptation, climate change, risk perception, resources and capabilities, multilevel

RESUMO

O tema das mudanças climáticas ainda é muito negligenciado apesar de urgente para a sociedade. Frequentes eventos climáticos extremos, incêndios, elevação do nível do mar, entre outros, são efeitos esperados para os quais as organizações devem se preparar e se adaptar. Este artigo apresenta uma revisão sistemática da literatura sobre adaptação às mudanças climáticas e analisa os fatores que influenciam as decisões estratégicas das organizações. Os resultados levam a um modelo elaborado para explicar o papel de tais fatores, considerando sua influência em níveis individual, organizacional e institucional. Esse estudo contribui para a literatura ao propor um modelo de adaptação ao clima e explicar a relação entre os fatores internos e externos e o contexto multinível. O modelo identifica a percepção de risco como um dos principais contingentes na adaptação climática das organizações, juntamente com recursos e capacidades organizacionais, stakeholders e parcerias no processo de adaptação ao clima. Por fim, são identificados como antecedentes importantes no processo de adaptação as políticas públicas, valores, experiência individual e capacidade cognitiva dos gestores.

PALAVRAS-CHAVE: adaptação, mudanças climáticas, percepção de risco, multinível, recursos e capacidades.

RESUMEN

El cambio climático es un asunto urgente para la sociedad, pero aún muy descuidado. Los frecuentes eventos climáticos extremos, incendios, aumento del nivel del mar, entre otros, son efectos esperados para los cuales las organizaciones deben prepararse y adaptarse. Este artículo presenta una revisión sistemática de la literatura sobre adaptación al cambio climático y un análisis de los factores que influyen en las decisiones estratégicas de las organizaciones. Los resultados conducen a un modelo elaborado para facilitar la comprensión de dichos factores, considerando su nivel de influencia: individual, organizativa e institucional. Este estudio contribuye a la literatura al proponer un modelo de adaptación al cambio climático y explica la relación entre los factores internos y externos en un contexto multinivel. El modelo identifica la percepción del riesgo como uno de los principales factores contingentes en la adaptación al cambio climático juntamente con los recursos y capacidades organizacionales, las partes interesadas y las alianzas. Finalmente, las políticas públicas, los valores, la experiencia individual y la capacidad cognitiva de los directivos se identifican como antecedentes importantes en el proceso de adaptación.

Palabras clave: adaptación, cambio climático, percepción del riesgo, multinível, recursos y capacidades.

INTRODUCTION

Climate change presents major risks for a wide array of businesses and society as a whole. The scientific evidence of climate change demonstrates the unequivocal influence that humans have had on greenhouse gas (GHG) emissions in recent centuries and the consequences of the warming of the atmosphere, oceans, and the land (Intergovernmental Panel on Climate Change [IPCC], 2022). The increasing occurrence of natural disasters, such as floods, storms and wildfires, and extreme weather represent a threat to business operations (Centre for Research on the Epidemiology of Disasters [CREED], 2020). Climate change has become a norm in the business context, and organizations must be able to adapt to adverse environmental conditions (Howard-Grenville, Buckle, Hoskins, & George, 2014; Rivera & Clement, 2019; Vergne & Depeyre, 2016).

Companies need to adapt their assets, operations, and value chains to face the risks of climate change in different ways. For example, increasing temperatures and extreme weather affect productivity in agribusiness (Arunrat, Wang, Pumijumnong, Sreenonchai, & Cai, 2017; Galbreath, 2014; Hamilton-Webb, Manning, Naylor, & Conway, 2017), while reduced snowfall and rise in sea-levels affect tourist destinations (Dawson & Scott, 2013; Orr & Inoue, 2019; Trawöger, 2014). Climate change challenges business operations to a greater or a lesser extent and has the potential to cause disruption. In an emblematic case, Californian wildfires led the large utility firm PG&E Corp to bankruptcy in 2019 (Gold, 2019).

Despite this climate emergency, studies show that responses to climate risks vary widely, from proactive and innovative initiatives to reluctance and inaction (Gasbarro, Rizzi, & Frey, 2016; Herrmann & Guenther, 2017; Linnenluecke, Griffiths, & Winn, 2012). Several factors and contextual aspects influence the adaptation to climate change. For instance, the impacts of climate change vary geographically, and not all regions and countries are equally exposed to its effects (Steiger & Scott, 2020). Countries also have different resilience capabilities, with developing economies tending to suffer higher economic losses as a result of extreme weather events (Haque, 2016; IPCC, 2012; Minucci, 2016). Public policies and incentives help strengthen private adaptation at the institutional level, hence the difficulty of analyzing the phenomenon only at the organizational level (Rivera & Clement, 2019). Environmental changes involve uncertainties concerning impacts, in which institutional support is crucial (Mashizha, 2019; Paschen & Ison, 2014; Sacchelli et al., 2017).

Additionally, the adaptive responses of companies are conditioned by the level of risk perceived by their managers and their available resources and capabilities (Berkhout, 2012; Busch, 2011; Doh, Tashman, & Benischke, 2019). Company adaptation is the essence of organizational strategy and survival (Chakravarthy, 1982), but the need to change a course of action demands the development of a new repertoire of solutions (Laureiro-Martínez & Brusoni, 2018). Therefore, awareness of the situation and heightened attention are important starting points for capturing the environmental signs of any anomalies and/or risks. The perception of climate risk is influenced by, among other things, socio-demographic aspects, previous experience, and knowledge (Linden, 2015; Weber, 2016), while decision-making takes place in a multilevel structure in which factors interact on different hierarchical levels that direct the development of corporate adaptation strategies.

This article examines the challenge of organizational adaptation to climate change by systematizing the factors that influence such decisions and the context in which they occur. A systematic literature review was conducted, in which we seek to answer the following questions: What major factors contribute to a business's adaptation to climate change? How do these factors act on different contextual levels in the climate change adaptation process?

This study is relevant because it identifies the drivers of adaptation and it considers the contextual variables that influence the process of change at different levels (Aguinis, Boyd, Pierce, & Short, 2011). Moreover, the results of this systematic review have the potential to guide new studies on the subject and encourage evidence-based management (Simsek, Fox, & Heavey, 2021). The issue of how companies adapt to the impacts of climate change is an emerging topic and deserve further research, considering that studies on mitigating emissions are more frequent (Berkhout, Hertin, & Gann, 2006; Galbreath, 2011; Hoffmann, Sprengel, Ziegler, Kolb, & Abegg, 2009; Tashman & Rivera, 2016). Climate change adaptation has been lagging behind as a non-priority in business decisions, even though the vulnerability resulting from the "business-as-usual" approach has been increasing (Nyberg & Wright, 2020), hence the usefulness of this literature review in terms of research and practice.

The systematic literature review led to the development of a multilevel model of climate change adaptation, in which we examined the factors at the individual, organizational, and institutional levels. The model also identifies the role of various factors in the organizational strategy process according to the contingencies or antecedents of climate change adaptation.

The next section describes the methodology, presenting the steps taken in carrying out the systematic literature review. The subsequent section examines the findings in terms of their approach to climate change adaptation and considering the factors identified, introducing and detailing the multilevel model. Finally, the study's conclusions are presented.

METHODOLOGY

The systematic literature review was the methodology chosen based on its capacity to address the study's research questions. This approach provides a comprehensive overview of existing research and allows the search to be specific and transparent with regard to procedures and relevant knowledge (Tranfield, Denyer, & Smart, 2003). It offers an integrative approach, in which analysis of the findings and concepts are organized in higher-order categories to advance the research (Simsek et al., 2021). For this purpose, this review offers a model encompassing the contextual levels of factors that influence the organizations' adaptation to climate change.

The study was carried out following the five steps used for a systematic literature review, as detailed in Exhibit 1 (Tranfield et al., 2003). The first step involved formulating the research questions (Q1 and Q2), after which the search criteria were defined. In the second step, the literature search considered the period between 2007 (the year of the IPCC's Nobel laureate) and 2020. Given the interdisciplinary aspects of climate adaptation, we also used the Scimago Lab classification to screen the business literature found in other fields of research. Therefore,

the search included journals ranked in the first and second quartiles by Scimago Lab under the business, management, and accounting areas, and under strategy and management (as per the 2020 classification). ‘Climat*’ and ‘adapt*’ search strings were applied to the title, keywords, and abstracts of the selected journals.

Exhibit 1. Systematic review steps

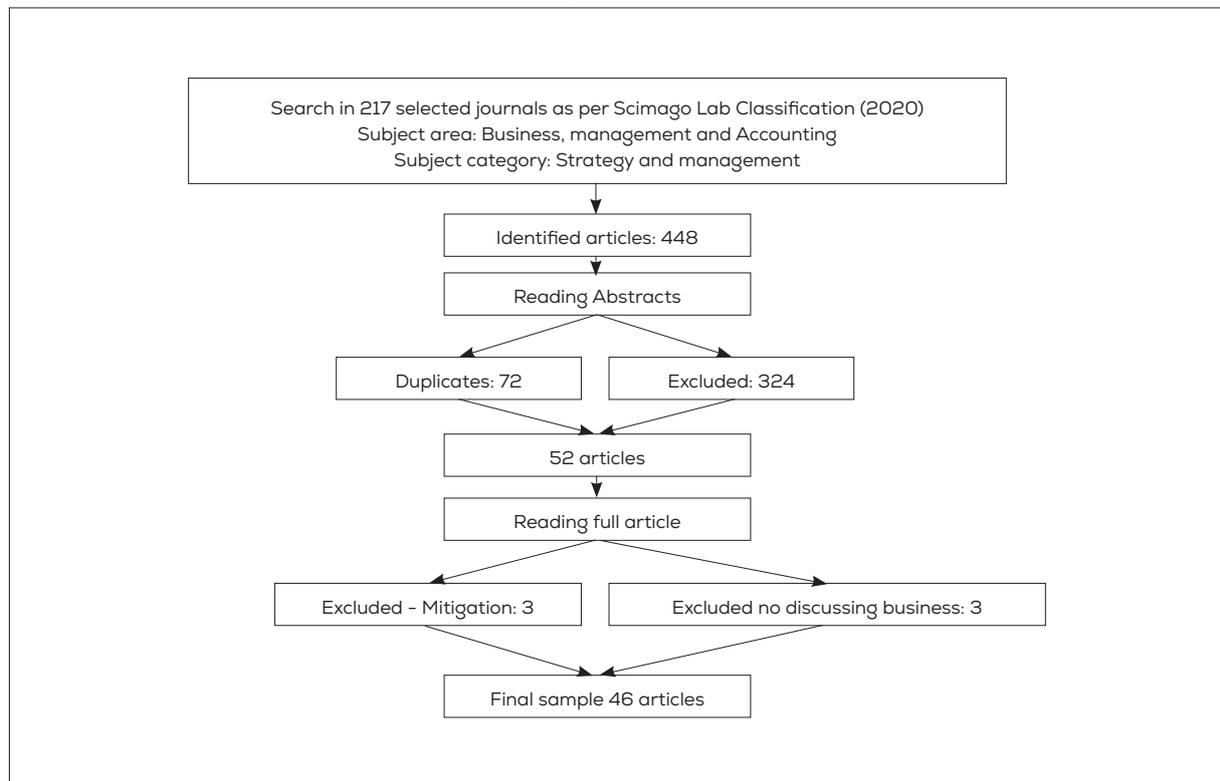
Steps	The article
1 Formulating the research questions	<ol style="list-style-type: none"> 1. What major factors contribute to a business's adaptation to climate change? 2. How do these factors act on different contextual levels in the climate change adaptation process?
2 Searching the literature	<ul style="list-style-type: none"> • Selection of the database: journals listed in Scimago Lab in the Business, Management and Accounting subject areas, and under the Strategy and Management subject category. • Key search words: ‘climat*’ and ‘adapt*’. • Publication period: between 2007-2020
3 Selection and evaluation	<ul style="list-style-type: none"> • Exclusion of duplicates • Analysis and screening of relevant articles: <ol style="list-style-type: none"> 1. Do the articles investigate climate change adaptation? 2. Does the investigation include business level aspects?
4 Analysis and synthesis	<p>Coding selected articles:</p> <ol style="list-style-type: none"> 1. Research objective 2. Method 3. Unit of analysis 4. Context of discussion 5. Research approach 6. Adaptation factors (antecedents/contingents) 7. Level of the factor
5 Reporting and using the findings	Framework synthesis and generating a model of influence factors.

The first search resulted in 448 (Figure 1) articles, analyzed and screened considering the content of their abstracts. At this stage, duplicates (72) and articles that were beyond the scope of the study (273) were excluded. This analysis and screening of the articles considered adaptation (of human systems), which was defined “as the process of adjustment to actual or expected climate change and its effects, in order to moderate harm or exploit beneficial opportunities” (IPCC, 2012, p. 36). The systematic literature review focused on business adaptation as the ability of private organizations to react and respond to the impacts or the vulnerabilities caused by climate change events. Articles focused on emissions mitigation and/or discussing solely public adaptation (non-business scope) were excluded. The screening process showed that fewer studies are devoted to businesses adapting to climate change in comparison to individuals and society studies of adaptation.

The review process led to the selection of 52 articles for full reading, from which six articles were excluded for the reasons mentioned above (addressing emission mitigation and non-business scope). The final sample consisted of 46 articles that were coded in terms of their research objective, methodology, the context of the discussion, research approach, and factors investigated (see details in Exhibit 1).

In terms of adaptation factors (antecedents and/or contingents), we first retrieved the original quotes and systematized them into a set of 25 generic factors. For example: “Flood experience” and “Disaster experience” factors were consolidated into “Experience,” while “Normative actions” and “Institutional voids” were consolidated into “Institutions/policy.” Finally, we categorized the factors according to their level of influence (socio-cultural, institutional, organizational, and individual) and formulated their contributions to literature. The idea of a multilevel model was pre-conceived base on the literature and shaped the research questions (Aguinis et al., 2011; Linden, 2015). However, the model’s development was supported by the review’s findings and corroborated by the data analysis (Simsek et al., 2021).

Figure 1. Literature evaluation and screening



FINDINGS

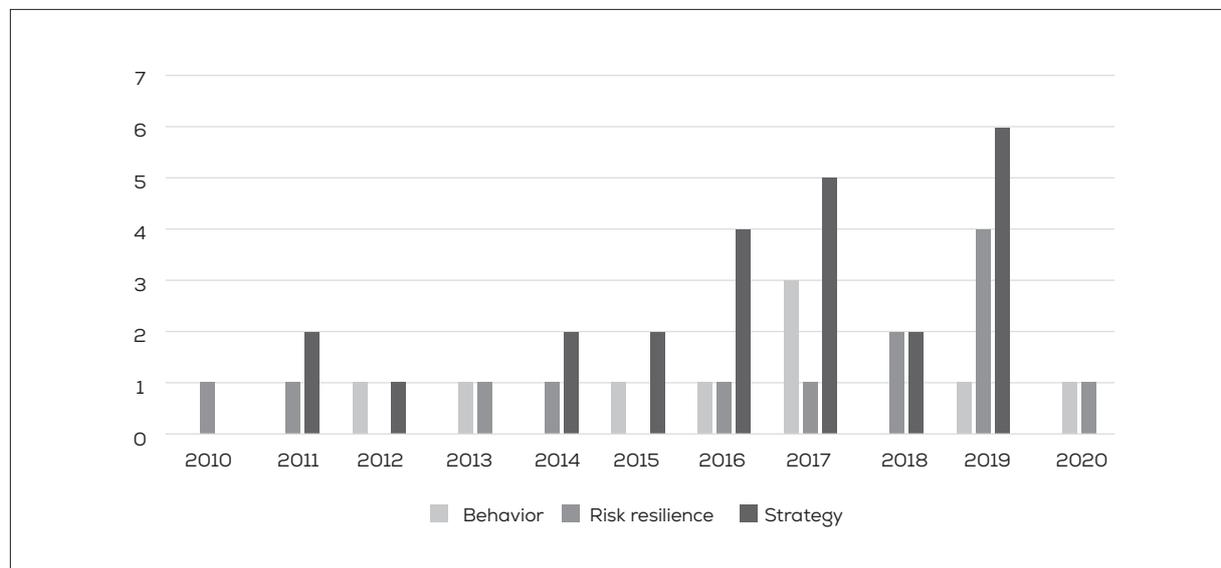
The research findings are reported in three sub-sections designed to advance the understanding of the factors that influence the organizations’ adaptation to climate change. The first sub-section summarizes the final sample of 46 articles, with a descriptive analysis of the articles by publication date, journal, research approach, methodology, industry, and regions studied. This analysis helps to understand the development of the studies on climate change in the business field. The second sub-section observed the selected article’s research approaches in climate change adaptation, showing the approaches they adopted (business strategy, risk, and

resilience). The third sub-section synthesizes the findings related to the influence factors and their contextual levels.

Sample description

The research approach used in most of the studies (26) focused on strategic decision-making related to the adaption measures introduced and the availability of adaption capabilities. Some studies (13) were dedicated to the climate risk assessment process, analyzing vulnerabilities, and the resilience capabilities of businesses. Finally, some (7) focused on analyzing the behavioral aspects behind climate change adaptation. Interestingly, even though the period covered by the articles in this study started in 2007, the first article identified in this review was published in 2010 (Wedawatta, Ingirige, & Amaratunga, 2010), in which the authors investigate the issue of climate resilience in the construction industry. However, over time more publications addressed the strategic aspects of organizational adaptation (Figure 2).

Figure 2. Publications per year and research approach



N=46

Most of the articles (80%) presented empirical studies in which some of the most vulnerable sectors were frequently cited, such as tourism and agriculture (Table 1). Most of these studies were conducted in Europe, North America, East Asia, or the Pacific regions, with few studies undertaken in South America or Africa. Geographical differences are relevant to climate change adaptation, not only because of their physical vulnerability to climatic events but also because of the different contexts of policies related to climate change adaptation.

Table 1. Industries and region studied

Industry	Africa	Asia	East Asia & Pacific	Europe	North America	South America	Generic	%
Tourism				4	4			17%
Agriculture	1		3	1				11%
Winery			1	1				4%
Oil And Gas						1	1	4%
Utilities				1			1	4%
Aviation							1	2%
Construction				1				2%
Electricity Utilities				1				2%
Fishery					1			2%
Food				1				2%
Manufacturing				1				2%
Sport							1	2%
Water Management						1		2%
Not Specified		2	4	4	4		5	41%
Total	1	2	8	15	9	2	9	46

The sample shows that 61% of the articles were published in three journals, *Tourism Management*, *Journal of Cleaner Production* and *Business Strategy and the Environment*, which focus on sectorial and thematic aspects of business management. Although climate change has been recognized as a great challenge to business management (George, Howard-Grenville, Joshi, & Tihanyi, 2016; Howard-Grenville et al., 2014), the study of climate change adaptation is still not commonly featured in general management journals.

Table 2. Articles per Journal

Journal	Number of Articles	%
Tourism Management	10	22%
Journal of Cleaner Production	10	22%
Business Strategy and the Environment	8	17%
Journal of Risk Research	4	9%
Scandinavian Journal of Management	2	4%
Corporate Social Responsibility and Environmental Management	2	4%
Sport Management Review	1	2%
Socio-Economic Planning Sciences	1	2%
Research Policy	1	2%
Organization	1	2%
Journal of Multi-Criteria Decision Analysis	1	2%
Journal of Destination Marketing and Management	1	2%
Journal of Air Transport Management	1	2%
International Journal of Strategic Property Management	1	2%
Business Strategy and Development	1	2%
Academy of Management Perspectives	1	2%
Total	46	

Research approaches in climate change adaptation literature

The studies address organizational adaptation to climate change as a strategic issue, a risk-resilience concern and/or a behavioral issue. Most of the studies focus on the strategic aspects of climate change adaptation in terms of the ability of organizations to adjust their resources to fit the changing external environment (Winn, Kirchgeorg, Griffiths, Linnenluecke, & Gunther, 2011). Therefore, the studies focus on analyzing the organization-level factors, resources, and capabilities that enable adaptive responses (such as Busch, 2011; Minucci, 2016; Rahmawati, Jiang, & DeLacy, 2019). On the other hand, some studies focus on internal and external factors (but mainly external) and are barriers to adapting to climate change (Herrmann & Guenther, 2017; Masud et al., 2017). In a broader sense, some studies approach adaptation and the resilience capacity to reduce businesses' vulnerability to climate change and extreme weather (Haque, 2016; Linnenluecke et al., 2012; Ruttu et al., 2017).

The risk and resilience approach involves steps such as being prepared to cope with climate vulnerability and the risk of extreme weather events (Beermann, 2011; Orr & Inoue, 2019) and the development of climate resilience (Burbidge, 2018; Tisch & Galbreath, 2018; Wedawatta et al., 2010). Risk and resilience studies also investigate the level of climate awareness and the risk perception of managers in organizations (such as Gasbarro et al., 2016; Trawöger, 2014). Finally, some studies investigate factors that influence risk perception, behavior, and attitudes toward climate change (such as Hamilton-Webb et al., 2017; Ngo, Poortvliet, & Feindt, 2019).

Studies of behavioral and attitudinal aspects refers to businesses' decision-making in terms of adapting to climate change (Brink & Wamsler, 2019; Schliephack & Dickinson, 2017). They evaluate the influence of cognitive aspects, values, and beliefs on the actors' preferences and the process of managerial decision-making with regard to climate change (Brink & Wamsler, 2019; Bujosa, Riera, & Torres, 2015; Lei, Voss, Clegg, & Wu, 2017).

The three research approaches found in the climate adaptation literature emerge from different objectives regarding the factors of influence. Behavioral studies search for individual, socio-cultural, and institutional determinants, whereas business strategy and risk-resilience studies investigate organizational resources and capabilities as drivers or barriers. In the next section, we present the factors in terms of their context level.

Multilevel influence factors

This review aims to integrate the literature on climate change adaptation and explain the different levels of influence. The levels are higher-order categories that integrate related concepts and differentiate them hierarchically (Simsek et al., 2021). The multilevel approach contributes to our understanding of the interconnectedness of the macro, meso, and micro-structures in which organizations find themselves (Aguinis et al., 2011). In the macro-dimension (socio-cultural and institutional), climate change is a great challenge for the whole of society, but it is one that each country addresses differently. Industry and organizations are grouped together at the meso-level of influence, while the behavior of managers and individuals constitutes the micro-level of influence in terms of climate change adaptation decisions.

We categorized the factors according to their level of analysis: socio-cultural, institutional, industrial, organizational, and individual (Exhibit 2). Starting from a broad perspective, culture and shared values are major collective factors of the socio-cultural context that influence public policy and the decisions made by individuals and organizations with regard to climate change adaptation (Brink & Wamsler, 2019; Herrmann & Guenther, 2017; Paschen & Ison, 2014). The cultural structure, which is a traditional framing of social values, shapes the perception and relevance attributed to natural events (Camare & Lane, 2015; Paschen & Ison, 2014). Shared values and beliefs about climate change shape society's engagement with adaptation (Brink & Wamsler, 2019; Chin, Day, Sydnor, Prokopy, & Cherkauer, 2019).

From the institutional point of view, collective behavior is guided by public policies and public proactivity for activating responses to climate risks (Daddi, Bleischwitz, Todaro, Gusmerotti, & De Giacomo, 2020; Mashizha, 2019; Sacchelli et al., 2017). Climate adaptation measures require investments, in which case level of income and economic situation are relevant for establishing priorities in different contexts (Gasbarro et al., 2016; Masud et al., 2017; Wissman-Weber & Levy, 2018). Public initiatives involving the development of technology, logistics, infrastructure, and investments in operations help overcome struggles in private initiatives and foster collective adaptation (Burbidge, 2018; Haque, 2016; Mashizha, 2019). Public governance introduces support for adaptation strategies, whereas institutional voids, such as unclear institutional guidance and political disputes over climate change, fail to convey a message of urgency to society.

At the industry level, the literature describes the dependence on natural resources as an important vulnerability. In this sense, industries such as energy, transportation, tourism, and agriculture are more likely to be adversely affected by climate change than others (Arunrat et al., 2017; Lei et al., 2017; Rivera & Clement, 2019; Weinhofer & Busch, 2013). Industry associations and conventions also play a relevant part in climate awareness and adaptation initiatives (Lei et al., 2017).

The adaptive capacity of organizations depends on their resources, capabilities, their relationship network, and structural aspects such as vulnerability and exposure. Organizational vulnerability – the likelihood of being adversely affected – influences the development of adaptation strategies (Orr & Inoue, 2019). And the organizational exposure – the resources and assets that might be adversely affected – is another of the structural aspects that drive anticipatory actions of adaptation (Gasbarro & Pinkse, 2016; Haque, 2016; Orr & Inoue, 2019; Wedawatta et al., 2010).

Adaptation is conditioned by the capacity of organizations to learn from their own experience and from the experience of others. This involves activating internal learning processes (Minucci, 2016; Schmitt & Klarner, 2015) and learning from others socially (Arunrat et al., 2017; Nicolletti, Lutti, Souza, & Pagotto, 2019). The literature also deals with other relevant capabilities, such as knowledge of adaptation measures (Busch, 2011) and the capacity to innovate (Beermann, 2011; Busch, 2011). The availability of financial resources is frequently cited as either a facilitator of climate change adaptation or an obstacle to it (Arunrat et al., 2017; Beermann, 2011; Dawson & Scott, 2013; Haque, 2016; Herrmann & Guenther, 2017; Mashizha, 2019; Masud et al., 2017; Michailidou, Vlachokostas, & Moussiopoulos, 2016; Rahmawati et al., 2019; Wissman-Weber & Levy, 2018).

The studies also consider the role of leadership (Kang, Yoon, & Rhee, 2017; Lei et al., 2017; Minucci, 2016) and incentives (Chin et al., 2019; Herrmann & Guenther, 2017) in promoting organizational change. Organizations' stakeholders and their relationship networks act as both a source of pressure (Arunrat et al., 2017; Minucci, 2016) and partnerships for engaging stakeholders with climate change adaptation solutions (Canevari-Luzardo, Berkhout, & Pelling, 2019; Doh et al., 2019). A shared vision of climate events may give rise to the possibility of alliances, including public-private partnerships for implementing adaptation solutions (Canevari-Luzardo, Berkhout, & Pelling, 2019; Doh et al., 2019). A shared vision of climate events may give rise to the possibility of alliances, including public-private partnerships for implementing adaptation solutions (Doh et al., 2019; Minucci, 2016).

Finally, at the individual level, the results of the systematic literature review show that experiencing extreme weather events is one of the most important issues for stimulating learning and effective climate change adaptation (Arunrat et al., 2017; Hamilton-Webb et al., 2017; Kang et al., 2017; Linnenluecke et al., 2012; Masud et al., 2017; Ngo et al., 2019; Tisch & Galbreath, 2018). Individual experience affects the perception of climate risks, enhances climate knowledge, and motivates adaptation (Ngo et al., 2019). Risk perception and individual awareness are found to be positively associated with adaptation behavior and action (Canevari-Luzardo et al., 2019; Craig, 2019; Daddi et al., 2020; Gasbarro & Pinkse, 2016; Kang et al., 2017; Ngo et al., 2019; Trawöger, 2014; Wissman-Weber & Levy, 2018). Research into individual behavior also considers demographic aspects, emotions,

and cognition as relevant factors for individual attitudes to climate change adaptation, and as influence factors in the risk-judgement and decision-making processes of individuals (Brink & Wamsler, 2019; Craig, 2019; Dawson & Scott, 2013; Masud et al., 2017; Paschen & Ison, 2014).

Exhibit 2. Categorization of factors

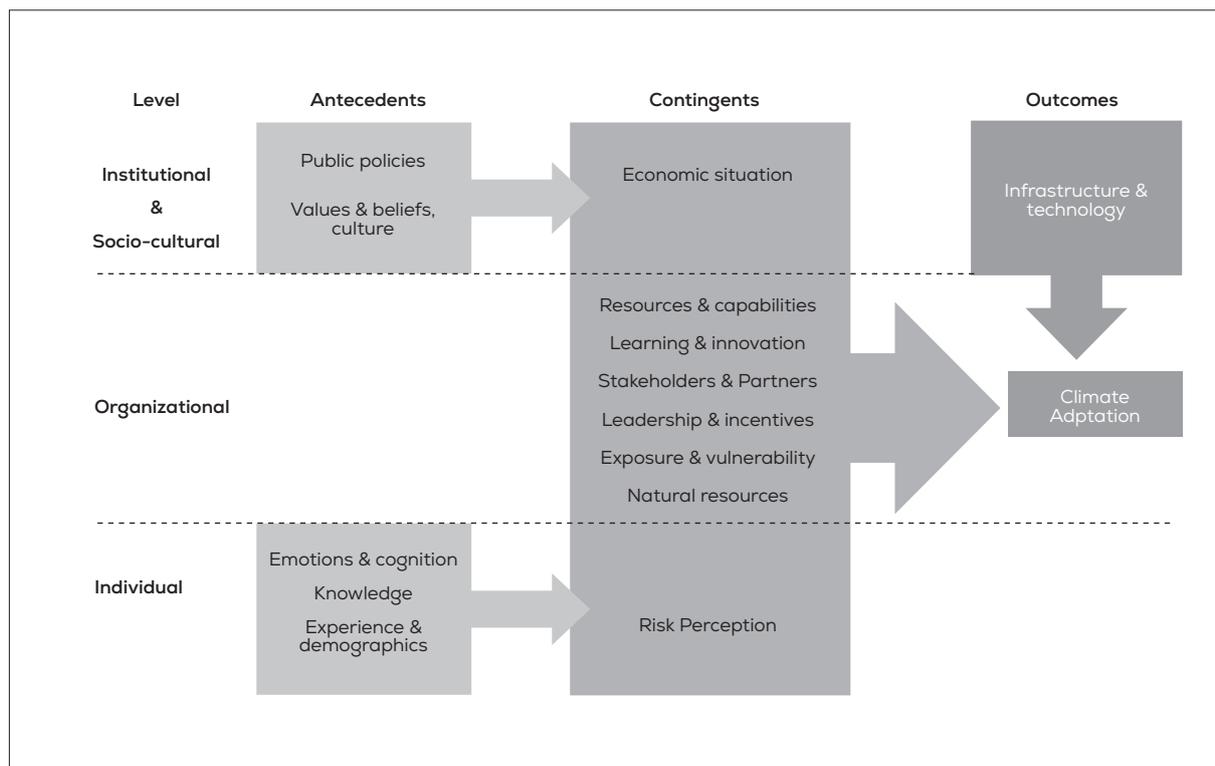
Level	Factors	Authors
Socio – Cultural	Beliefs/Values	(Brink & Wamsler, 2019; Chin et al., 2019; Lei et al., 2017; Linnenluecke et al., 2012)
	Culture	Brink & Wamsler, (2019); Herrmann & Guenther, (2017); Mostofi Camare & Lane (2015); Paschen & Ison (2014); Tisch & Galbreath (2018)
Institutional	Economic	Brink & Wamsler, (2019); Gasbarro et al., (2016); Masud et al. (2017); Mostofi Camare & Lane (2015); Wissman-Weber & Levy (2018)
	Institutions/ Policy	Daddi et al. (2020); Galbreath (2014); Haque (2016); Lei et al. (2017); Mashizha (2019); Masud et al. (2016); Paschen & Ison (2014); Sacchelli et al. (2017)
	Infrastructure & Technology	Burbidge (2018); Haque (2016); Mashizha (2019); Steiger & Scott (2020)
Industry	Natural resource dependence	Lei et al. (2017); Orr & Inoue (2019)
Organizational	Resources & Capabilities	Busch (2011); Chin et al. (2019); Gasbarro et al. (2016); Herrmann & Guenther (2017); Lei et al. (2017); Linnenluecke et al. (2012); Masud et al. (2017); Minucci (2016); Ngo et al. (2019); Orr & Inoue (2019); Rivera & Clement (2019); Steiger & Scott (2020); Wedawatta et al. (2010); Weinhofer & Busch (2013); Winn et al. (2011); Wissman-Weber & Levy (2018)
	Financial resources	Arunrat et al. (2017); Beermann (2011); Dawson & Scott (2013); Haque (2016); Herrmann & Guenther (2017); Mashizha (2019); Masud et al. (2017); Michailidou et al. (2016); Rahmawati et al. (2019); Wissman-Weber & Levy (2018)
	Innovation	Beermann (2011); Busch (2011)
	Learning	Arunrat et al. (2017); Minucci (2016); Nicolletti et al. (2019); Schmitt & Klarner (2015)
	Knowledge	Busch (2011); Chin et al. (2019); Herrmann & Guenther (2017); Rahmawati et al. (2019)
	Leadership	Kang et al. (2017); Lei et al. (2017); Minucci (2016)
	Incentive	Chin et al. (2019); Herrmann & Guenther (2017)
	Stakeholders & Partnerships	Arunrat et al. (2017); Canevari-Luzardo et al. (2019); Doh et al. (2019); Michailidou et al. (2016); Minucci (2016); Nicolletti et al. (2019); Orr & Inoue (2019)
	Exposure & Vulnerability	Gasbarro & Pinkse (2016); Haque (2016); Orr & Inoue (2019); Wedawatta et al. (2010)
	Risk Management	Beermann (2011); Canevari-Luzardo et al. (2019); Rahmawati et al. (2019)
Individual	Risk Perception	Canevari-Luzardo et al. (2019); Craig (2019); Daddi et al. (2020); Gasbarro & Pinkse (2016); Kang et al. (2017); Ngo et al. (2019); Trawöger (2014); Wissman-Weber & Levy (2018)
	Demographics	Dawson & Scott (2013); Masud et al. (2017)
	Emotions & Cognition	Brink & Wamsler (2019); Craig (2019); Paschen & Ison (2014).
	Experience	Arunrat et al. (2017); Hamilton-Webb et al. (2017); Kang et al. (2017); Linnenluecke et al. (2012); Masud et al. (2017); Ngo et al. (2019); Tisch & Galbreath (2018)
	Knowledge	Ngo et al. (2019)

Most studies consider factors implicated in more than one dimension, from the macro to the micro-level. Indeed, climate change adaptation is a multilevel phenomenon, and organizational adaptation strategies are subordinated to the institutional and social context and influenced by a perception of the urgency of individuals, such as managers, owners, clients, and other stakeholders. The literature review also prompts discussion on the interplay between climate risk and the development of adaptive responses and resilience. Therefore, based on the findings above, the next section presents a dynamic model of climate change adaptation strategy.

ADAPTATION STRATEGY MODEL

Adapting to climate change depends on different factors and the engagement of different actors both inside and outside the organization. In order to summarize the complexity of this scenario, this review proposes a multilevel model centered at the organizational level and focuses on the paths to climate change adaptation as the main strategic outcome (Figure 3). The model consolidates the factors identified in the systematic literature review according to their role in the process of organizational adaptation. Therefore, organizational adaptation to climate change is contingent upon organizational, individual, and institutional-level factors. The development of such factors depends on outside inputs from individual-level (managers) factors, institutions, and socio-cultural aspects.

Figure 3. Multilevel model for climate change adaptation



Adaptation contingents

Organizational change and adaptation are strategic to business survival and success in a changing environment (Chakravarthy, 1982). Business strategy literature suggests that adaptation depends on the existence of resources, (dynamic) capabilities, and the managerial mind-set related to a particular purpose (Vergne & Depeyre, 2016; Zollo, Bettinazzi, Neumann, & Snoeren, 2016). Totally different from adaptation, organizational inertia generates blind spots with regard to changes in the environment and leads to errors when responding to vulnerabilities (Rivera & Clement, 2019; Weick & Sutcliffe, 2006). Climate skepticism and inaction are usually associated with uncertainty about climate change and cognitive bias (Weber, 2015). Some of the articles selected in this review explored the barriers to adaptation that could lead to inaction, such as financial resources, collective knowledge, internal (organizational) incentives, and others (Herrmann & Guenther, 2017; Masud et al., 2017).

The systematic literature review suggests that organizations need to develop *resources and capabilities* in response to shifting environmental conditions (Gasbarro & Pinkse, 2016; Haque, 2016; Orr & Inoue, 2019; Wedawatta et al., 2010), and this includes the availability of financial resources (Masud et al., 2017; Rahmawati et al., 2019).

The *learning and innovation* process occurs by observing environmental changes and by interacting with stakeholders and partners (Arunrat et al., 2017; Minucci, 2016; Nicolletti et al., 2019; Schmitt & Klärner, 2015). Not all organizations have the same capacity for exploring new possibilities and developing knowledge. In this sense, an alliance with *stakeholders and partners* is important for helping adjust assets and co-creating solutions (Arunrat et al., 2017; Canevari-Luzardo et al., 2019; Doh et al., 2019; Michailidou et al., 2016; Minucci, 2016; Nicolletti et al., 2019; Orr & Inoue, 2019). Organizational *exposure and vulnerability* increase the demand for adaptation measures and innovation in products and processes (Beermann, 2011; Busch, 2011), particularly if the business is dependent on *natural resources* (Lei et al., 2017; Orr & Inoue, 2019).

Organizational capabilities and learning depend on *leadership and incentives*, in terms of the capacity of the leaders to sense signs of anomalies in climate events and to develop the necessary incentives for promoting changes internally (Canevari-Luzardo et al., 2019; Craig, 2019; Daddi et al., 2020; Gasbarro & Pinkse, 2016; Kang et al., 2017; Ngo et al., 2019; Trawöger, 2014; Wissman-Weber & Levy, 2018). At the individual level, managers and leaders need the ability to sense signs of anomalies in climate events and to develop *risk perception* (Craig, 2019; Trawöger, 2014).

In parallel, but outside the organization, the *economic situation* may dictate the need to set other priorities and not convey a sense of urgency to adapt in order to protect the business from climate events (Brink & Wamsler, 2019; Camare & Lane, 2015; Gasbarro et al., 2016; Masud et al., 2017; Wissman-Weber & Levy, 2018). Finally, an important factor in developing organizational capabilities is the guidance offered by institutional-level initiatives in terms of *infrastructure and technology* (Burbidge, 2018; Haque, 2016; Mashizha, 2019; Steiger & Scott, 2020).

Adaptation antecedents

An organization's adaptive capabilities are part of the institutional context and the socio-cultural aspects, while the characteristics of individuals (managers) are the antecedents of adaptation decision-making. Adaptation requires a change in managerial *cognition and emotions* beginning with the micro-foundations of organizational capabilities to allow climate risk to be perceived (Brink & Wamsler, 2019; Craig, 2019; Paschen & Ison, 2014).

Assessing climate risk is also influenced by personal experience and intense examples of extreme weather (Arunrat et al., 2017; Hamilton-Webb et al., 2017; Kang et al., 2017; Linnenluecke et al., 2012; Masud et al., 2017; Ngo et al., 2019; Tisch & Galbreath, 2018). Climate change is also an abstract issue, so experiencing it is a valuable source of information and important for developing first-hand *knowledge* of climate vulnerability (Ngo et al., 2019).

Experience and demographics impact the appraisal of vulnerability to climatic events. Socio-demographic aspects, such as gender, age, and education, also influence the perceived risks of climate change (Dawson & Scott, 2013; Masud et al., 2017). Studies have found that women have a higher risk perception and are less skeptical about climate change (Brink & Wamsler, 2019; Ngo et al., 2019). *Values and beliefs* also shape risk perception, the stakeholders' priorities, and the learning process of individuals (Brink & Wamsler, 2019; Chin et al., 2019; Lei et al., 2017; Linnenluecke et al., 2012).

Finally, *public policies* are the result of government initiatives introduced to address vulnerabilities and the urgent need for change (Daddi et al., 2020; Galbreath, 2014; Haque, 2016; Lei et al., 2017; Mashizha, 2019; Masud et al., 2016; Paschen & Ison, 2014; Sacchelli et al., 2017). Public policies are also important for encouraging action through economic incentives, such as taxes and subsidies to induce adaptation (Masud et al., 2016; Rahmawati et al., 2019; Sacchelli et al., 2017). Adaptation strategies also form part of the cultural context of countries (Brink & Wamsler, 2019; Camare & Lane, 2015; Herrmann & Guenther, 2017; Paschen & Ison, 2014; Tisch & Galbreath, 2018).

CONCLUSION

Although urgent, adapting to climate change is not a pressing issue in business strategy and decision-making. This systematic literature review demonstrated that the study of climate change adaptation has received less attention than emission mitigation and it needs to be further explored. This review integrates factors that influence the organizations' adaptation processes and proposes a multilevel model to help understanding climate change adaptation.

By focusing on organizational adaptation, this review emphasizes the role of resources and capabilities as enablers of climate change adaptation. Climate change will affect both processes and assets, and organizations are not all equally capable of learning and reconfiguring their resources (Buckley, Doh, & Benischke, 2017; Nicolletti et al., 2019). The ability to adapt to the fast-

moving environment and change existing processes and routines can potentially impact the competitiveness and survival of firms (Rivera & Clement, 2019). This may represent an additional challenge to some sectors, such as agriculture and tourism, for which climate change represents an unexpected shift in industry practices.

The second contribution of this article refers to integrating the perception of climate risk and organizational adaptation into one model that proposes a conditional relationship between the perception of climate risks and adaptation attitude. Since adaptation measures and innovation need an appropriate environment to develop and be assimilated, the model also helps identify the antecedent and contingential factors for achieving adaptation. These factors include institution-level initiatives and social and individual aspects that enhance perception, awareness, and the ability to seize opportunities.

This systematic literature review offers a timely and transparent compilation of the climate change adaptation process of business. However, because of its methodology, the results are restricted to information that has been published in peer-reviewed journals. Moreover, despite the broad aspect of climate change adaptation, this review is limited to business publications: reports and practical literature were not considered.

The discussion and the multilevel model presented have important practical implications for business and public policy orientation. However, the theoretical aspect of this article needs empirical validation, and testing the model is an opportunity for future studies. The proposed model invites further research to test causal contingents and antecedents and their capacity for predicting organizational adaptation. Future research could analyze different business environments and the influence of individual and social cognition. Finally, future research could encompass the level of adaptation on the supply and demand sides of the value chain.

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AUTHOR'S CONTRIBUTION

Renata Peregrino de Brito worked on the conceptualization and theoretical-methodological approach, theoretical review, data collection, data analysis and in the writing and final revision of the manuscript.