



Review

Business adaptation strategies to climate change: A systematic review

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ABSTRACT

Climate change pressures businesses to adapt, but knowledge on adaptation strategies remains fragmented. This systematic literature review addresses this gap by advancing the adaptation field in three ways. First, it expands the conceptualization of business adaptation strategies through a novel classification based on depth, time, locus, and tactic. Second, it identifies five key determinants influencing adaptation decisions: regulatory and stakeholder pressures, industry specificities, business network features, organizational capabilities, and individual characteristics. Finally, the review proposes a comprehensive framework with three tiers: 1) determinants at various levels, 2) types of adaptation strategies, and 3) adaptation impacts. This framework offers novel research avenues for scholarship and enables a more nuanced assessment of the impact of adaptation strategies. Additionally, a 'reverse roadmap' is proposed to help practitioners and policymakers navigate from desired adaptation outcomes back to current choices, increasing resilience while limiting maladaptation risks.

1. Introduction

Many businesses find themselves simultaneously on the “giving hand” of climate change (CC), contributing to the process through their emissions (Weinhofer and Busch, 2013), and on the “receiving hand,” affected by the intensification of existing and brand new climate-related risks (Linnenluecke et al., 2015). While mitigation efforts have garnered the bulk of the attention, businesses' ability to adapt is gaining steam with policymakers, practitioners, and scholars amid exacerbating manifestations of CC.

While adaptation to changing circumstances is “everyday business” for companies—they can be defined as adaptively rational systems (Cyert & March 1963) trying to navigate “economic and market discontinuities” (Linnenluecke and Griffiths, 2010, p. 485)—adapting to CC¹ might require a profound rethinking of current business strategies because of the scale, scope, and systemic uncertainty of CC—that is, a “massive discontinuous change” (Winn et al., 2011, p. 157). The adjustments that companies introduce in the face of CC typically aim to limit the negative financial implications of climate-related events, reduce costs, and occasionally leverage new climate-related sources of

competitive advantage (Gasbarro et al., 2016, p. 63).

Nevertheless, adaptation responses may vary from utter deferral to quick fixes for imminent vulnerabilities to continuous adaptation to actual and perceived risks. The need to identify the “internal resources and external conditions” (Berkhout et al., 2006, p. 153) that lead to this heterogeneity in adaptation responses is increasingly felt, both to better understand how companies might contribute to (or at least not harm) other objectives of the sustainability agenda (including, but not limited to, mitigation) and the conditions under which businesses remain competitive and resilient in front of wide-ranging environmental transformations (Bremer and Linnenluecke, 2017; Howard-Grenville and Lahnehan, 2021). This exercise is particularly relevant if one considers the potential for long-term damage stemming from current adaptation choices—i.e., maladaptation, “... a ‘cure’ that is worse than the ‘disease’” (Scheraga and Grambsch, 1998, p. 86) or, to use the definition in the IPCC's 6th Assessment Report, “the opposite of successful adaptation” (p. 166).²

Adaptation strategies remain poorly understood at the level of individual businesses, as pointed out by Linnenluecke et al. (2013) some time ago. Since then, several literature reviews have been conducted to

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¹ A broad definition of adaptation to CC from UN Climate Change is “... adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects” (see <https://unfccc.int/topics/adaptation-and-resilience/the-big-picture/what-do-adaptation-to-climate-change-and-climate-resilience-mean>, last retrieved: January 15, 2023).

² The report is available at https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_FullReport.pdf (last retrieved: February 14, 2023).

map strategies that can be pursued at the policy level—for example, focusing on specific territories (see, e.g., Bosomworth and Gaillard, 2019) or considering specific manifestations of CC, such as water scarcity (see, e.g., Kiguchi et al., 2021)—or at the household (see, e.g., Mortreux et al., 2020) or community levels (see, e.g., Mcdowell et al., 2016). Since the publication of the seminal review by Linnenluecke et al. (2013), however, no systematic attempts have been made to take stock of the emerging evidence from the scattered yet growing literature at the business level, except for narrative reviews (e.g., Howard-Grenville and Lahnenman, 2021) or reviews limited to specific sectors (e.g., aviation, reviewed in Ryley et al., 2020). This focus limits the possibility of understanding adaptation strategies at a broader level of analysis. An additional key gap in the literature is the lack of a comprehensive assessment of what factors are associated with successful adaptation strategies (versus maladaptation).

Given the current gaps in our understanding of business-level adaptation strategies to climate change, and in particular their determinants, we provide a systematic literature review of the growing body of research on this topic. We focus on mapping the determinants of different responses to climate change (rather than the determinants of climate inaction, as in, e.g., Slawinski et al., 2017; Wright and Nyberg, 2017). We identify five determinants and provide a novel conceptualization of adaptation strategies. Furthermore, we propose a finer-grained impact assessment scheme to move beyond the current dichotomous perspective, which only contrasts adaptive and maladaptive strategies.

Leveraging these results, we propose a three-tier framework incorporating determinants, types of strategies, and impacts. We envision this framework as an example of “climate-proofing management research” (Nyberg and Wright, 2022), developed through a systematic literature review for the benefit of scholars, practitioners, and policymakers. As for our contribution to scholarship, our framework is a compass for researchers seeking to familiarize themselves with the state of the art in this fragmented field and looking for directions for future research, highlighting the most conspicuous research gaps. In terms of our contribution to informed practice, business leaders stand to gain from the enhanced conceptual clarity we provide regarding the discernible dimensions along which adaptation strategies differ, helping them build CC resilience for their businesses and sustainable business models. Our framework also serves as a reference for policymakers, aiding them in formulating policies that will limit the potential long-term negative externalities on people, the planet, and the economy associated with maladaptation.

This review is structured as follows. Section 2 describes the material and methods of our systematization. Section 3 presents our results. Section 4 discusses the results, focusing on the heuristic potential of our three-tier model. The concluding remarks follow.

2. Material and methods

To rigorously evaluate the scholarly discourse on business-level adaptation strategies to climate change, we conducted a systematic literature review (SLR) (see, e.g., Dekkers et al., 2022; Denyer and Tranfield, 2009; Tranfield et al., 2003). This method ensures a transparent process for retrieving, appraising, and synthesizing pertinent studies—thus providing a comprehensive overview of the existing body of knowledge on this topic. Compared to other approaches to reviewing the literature, the SLR approach constitutes an objective and explicit methodology to ensure that all relevant studies are systematically included, rigorously assessed for quality, and analyzed for key insights. As it follows a standardized protocol, this method enables replicability for future studies. Furthermore, this method enables the identification of context-sensitive findings that are difficult to catch through bibliometric approaches. Finally, this method has the potential to guide policymakers and practitioners toward evidence-based decision-making rooted in scholarly research.

2.1. Eligibility criteria and information sources

Any SLR comprises several distinct steps. Each of these steps is essential for ensuring the rigor and reliability of the SLR methodology. The first is identifying the records to be considered for further analysis, cognizant of temporal boundaries, search areas, and inclusion and exclusion criteria (Dekkers et al., 2022). The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement was followed to identify the studies, as summarized in Fig. 1, which was built using the template of Page et al. (2021).

To identify relevant studies, we searched the Scopus database. Scopus is more comprehensive than ISI Web of Science and ensures a more selective identification procedure than Google Scholar, allowing us to identify higher-quality publications (Martín-Martín et al., 2018). We retrieved studies through a query that included the following criteria, aiming to maximize the chances of retrieving potentially relevant material to our research questions.

1. We looked within the abstract, title, or keywords for a keyword related to *business* and one related to CC to ensure alignment with our focus on adaptation to CC at the level of businesses;
2. We limited our search to journal or review articles due to their peer-reviewed nature, which guarantees a standard of quality and reliability. We excluded books, reports, and conference proceedings as they often offer broad—less empirical discussions and would, therefore, be difficult to compare with articles;
3. We limited our search to records written in English to ensure the feasibility of content analysis. Other reasons for our restriction to the English language are the complexity and resource demands of translating non-English publications and the predominance of English in leading journals;
4. We limited our search to records published in journals within the *Business, Management, and Accounting* subject area of Scopus, a collection of roughly 370 journals, ensuring the consistency of the terminology employed and a focus on the business level;
5. To ensure a stable dataset for analysis during the systematization process, we conducted the search in early 2022, limiting the query to papers published up to and including 2021.

Appendix 1 reports the results of essential bibliometric analyses of the 338 studies identified through our Scopus query.³

As a robustness check, we inspected the most frequently cited studies in our collection of 338 papers, to check if our query had omitted influential and potentially relevant studies – a practice known as snowball sampling (Dekkers et al., 2022, p. 174). We used the R-package *bibliometrix* (Aria and Cuccurullo, 2017) to generate the most frequently cited references within our sample. We ranked studies in descending order of citations and excluded studies already in our sample. No specific guidance exists regarding how many studies it is appropriate to include from a list of highly cited studies (Dekkers et al., 2022, p. 174). Drawing conclusions on the impact of research based on citations is also controversial since older papers typically accumulate more citations (*id.*). Faced with a wide margin of discretion, we looked for a sharp discontinuity among citations, which occurred below the eleventh

³ The exact search string used in the query reads as follows: *TITLE-ABS-KEY* (“*adapt**”) AND (“*climate change**” OR “*global warming**” OR “*climate cris**”) AND (“*corporat**” OR “*firm**” OR “*compan**” OR “*business**” OR “*enterprise**” OR “*organi?ation**”) AND (LIMIT-TO (SUBJAREA, “BUSI”)) AND (EXCLUDE (PUBYEAR, 2022)) AND (LIMIT-TO (LANGUAGE, “English”)) AND (LIMIT-TO (DOCTYPE, “ar”) OR LIMIT-TO (DOCTYPE, “re”)). The search string was iteratively refined to optimize its accuracy and relevance to this review’s specific scope. Drawing inspiration from the querying process outlined by Linnenluecke et al. (2013), we made adaptations to ensure a more tailored approach to our research objectives.

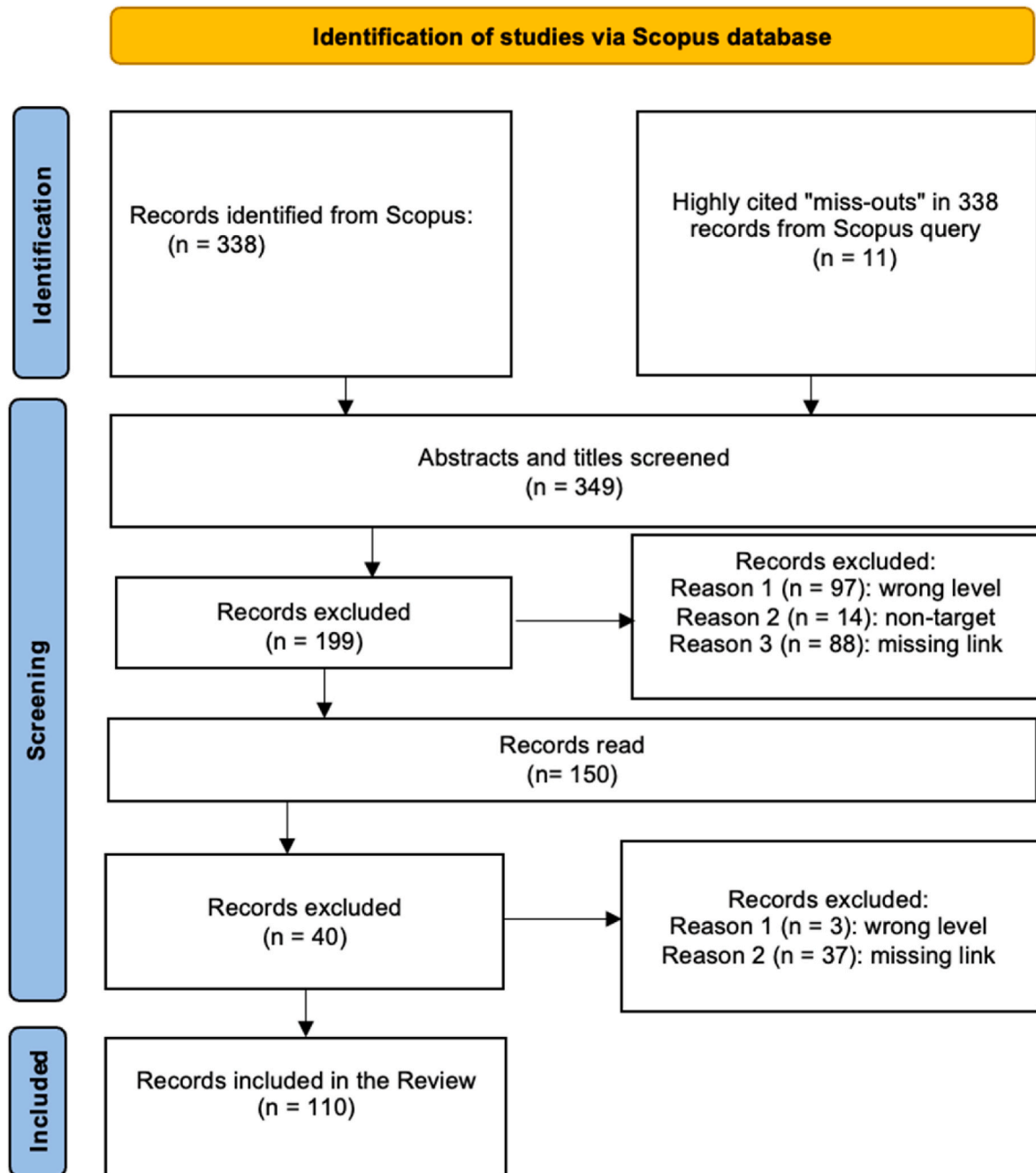


Fig. 1. Identification, screening, and inclusion criteria.

highly-cited study, and we added those 11 studies to our sample (final $n = 349$; see Fig. 1).

2.2. Selection process⁴

The two authors read the abstracts of each study. In cases where one of the following conditions applied, the records were excluded from further analysis.

1. *Wrong level*: Studies zooming in on the city or regional level and those taking a macro or economy-wide perspective on the adaptation issue were excluded. We introduced this criterion to underscore our interest in adaptation choices at the *business* level.
2. *Non-target study type*: We excluded editorials that did not support claims through empirical evidence. We also excluded papers whose main objective we assessed to be to inform industry operators (particularly in winter tourism) and local policy debates. These papers were unlikely to contribute significantly to our investigation of adaptation strategies' attributes, determinants, and consequences.
3. *Incidental and disjointed use of search terms*: Studies that made only cursory mentions of the lemmas "adapt," "climate change" (and similar expressions), and "business" (and synonyms), without integrating these terms into a coherent discourse, were excluded.⁵ Such papers were unlikely to provide substantive insights into our domain of investigation at the nexus of business adaptation strategies and climate change. This criterion ensured that the content analysis focused on this critical junction.

Disagreements between the two authors were resolved by a joint analysis of the articles excluded by one of the authors. A unanimous decision was reached on all records. A total of 199 studies were excluded based on reading the abstracts. Forty additional studies were excluded (by common agreement) after examining the full text of the papers based on the same criteria, resulting in 110 papers considered in the analysis.

2.3. Methods of analysis and synthesis

To rigorously analyze our textual corpus in a way that would allow us to extract relevant information, we used a combination of qualitative methodologies—namely, thematic synthesis, grounded theory, and hypothetico-deductive research (see Dekkers et al., 2022, and references cited therein for each of these methodologies). Therefore, our methodology incorporated inductive and hypothetico-deductive elements.

The analysis of the textual corpus began with an open coding process (Corbin and Strauss, 2015). We imported the included studies into MAXQDA 2022 software for qualitative analysis. Based on recurrent concepts and keywords that emerged at the title and abstract screening stage (e.g., "snowmaking" and "capabilities"), we constructed a dictionary and proceeded to a dictionary-based content analysis using an automatic coding function built into the software. This exercise generated a collection of coded segments that were vetted manually. New codes were added during the analysis of the textual corpus as new themes were uncovered. Based on a process of recursive abstraction (Dekkers et al., 2022, p. 353 and ff.), we went through several rounds of refinement of our thematic categories (as in the axial and then the selective coding stages of Corbin and Strauss, 2015), aiming for a robust set of categories. This inductive and "grounded" approach seemed appropriate, given the clusterization of our papers into two groups that

had seldom interacted (industry papers, especially focused on winter tourism, and a diverse group of nonindustry-specific papers; see Appendix 1). The ex-ante formulation of a model would have likely resulted in an un insightful synthesis, such as industry effects vs. "all else."⁶

An inductive process based on recursive abstraction was also employed to derive a parsimonious classification of adaptation strategies from the many different types of adaptation strategies discussed in the literature.

We also coded information pertaining to the impacts of adaptation strategies. Hypothetico-deductive research seemed appropriate in this case, given that we were aware of a generic concern with "maladaptation,"⁷ but we were unsure whether the literature had considered different time frames, types, and scopes of impact.

Appendix 2 provides a full bibliographic record of each study included in our review, the main theme of each study, and further information about our sample.

3. Results

3.1. Classification of adaptation strategies

Our content analysis revealed that many kinds of adaptation strategies were discussed in our sample of papers. Based on the content analysis, we propose that adaptation strategies can be classified along a well-defined set of dimensions – depth, time, locus, and tactic – which we will discuss in the following. This multidimensional classification adds clarity and tractability to the discourse on adaptation strategies for the benefit of scholars, practitioners, and policymakers. We also found that the four dimensions are often connected, as discussed below.

Depth. The first dimension along which adaptation strategies differ is the degree to which they purport to tackle the ultimate causes of CC (i.e., distinguishing between adaptation and mitigation). The consensus view in our sample of studies regarding adaptation vis-à-vis mitigation is that adaptation strategies are mostly reactive, whereas mitigation is viewed as an anticipatory effort to reduce or remove climate-related threats (Craig, 2019, p. 340). However, our analysis revealed nuances in the interplay between adaptation and mitigation, two chapters of the sustainability agenda that have been long compared and contrasted for their different foci and time horizons (e.g., in the IPCC's Fifth Assessment Report of 2014). Most authors subscribed to the view of the two approaches as substitutes; some viewed them as potential complements. According to the authors in the "substitutes" camp, adaptation strategies reduce CC-related risks, while mitigation strategies tackle the root causes of CC (Pinkse and Kolk, 2012; Rivera and Clement, 2019). Some predicted an escalation of the tension between the two objectives (mitigation and adaptation) in the future (e.g., Weaver, 2011). In the (minoritarian) "complements" camp, it was pointed out that proactive adaptation (as opposed to reactive adaptation; see the discussion of *time* below) contributes to the mitigation agenda and reduces the need for future adaptation (McLaughlin, 2011). Similarly, mitigation measures such as improving energy or water efficiency might also function as adaptation measures (especially in winter tourism; see Scott et al., 2016) or reduce the extent of maladaptation (Loehr, 2020). Instances were also provided in which it was impossible to reconcile the two objectives (Herrmann and Guenther, 2017; Michailidou et al., 2016).

Time. Another dimension along which strategies differed was the

⁴ The review protocol is available upon request from the corresponding author.

⁵ Our query, quoted verbatim in note 3, intentionally avoided a combined search for the lemmas "adapt" and "climate change" (and similar expressions). We deemed this alternative query too restrictive. The choice to search for these terms separately allowed us to cast a wider net for potentially relevant records.

⁶ We later show that industry specificities are part of our thematic synthesis. We achieve a finer thematic categorization of the nonindustry-focused literature.

⁷ The term "maladaptation," and variants, appears in 10 out of our 110 records, with a total of 30 occurrences.

timing of the adaptive responses (i.e. *when* a strategy is developed in response to the manifestations of CC).⁸ In this context, we found adaptation strategies such as wait-and-see (Berkhout et al., 2006; Gasbarro and Pinkse, 2016) and “passive” (Tervo-Kankare et al., 2018) or “reactive” (Fankhauser et al., 1999; Gasbarro and Pinkse, 2016) adaptation in response to exposure to CC effects, regulations, or requests from stakeholders. Adaptation initiatives occur after CCs’ effects have manifested in all those cases. On the contrary, “active” (Tervo-Kankare et al., 2018), “anticipatory” (Busch, 2011), and “pro-active” (Beermann, 2011) are the labels attached to cases in which the awareness of climate-related risks (a topic we return to in our discussion of adaptation determinants) prompts the adoption of adaptation measures even if climate-related damages on business activities are still of limited current significance (Gasbarro and Pinkse, 2016).⁹ A consensus view seemed to be consolidating in the literature, according to which an early adaptation time might lead to a superior (environmental and economic) performance in the long run, thereby connecting the dimensions of *time* and *depth* in our classification. A focus on keeping urgent CC-related vulnerabilities at bay, to accommodate the perceived need to maintain financial viability in the short run, may lead to neglecting long-term value-creation opportunities (Hoffmann et al., 2009; Klint et al., 2012).

Locus. Another relevant dimension to consider when examining different adaptation strategies is who is addressing the change, considering that most companies are embedded in long value chains within which every company is responsible just for one or more activities—the *locus* of adaptation. Companies might decide to pursue adaptation strategies that involve internal upgrades. Alternatively, they might outsource adaptation. The shifting of risks versus internal changes can be viewed as a make-or-buy decision (Kolk and Pinkse, 2005). Businesses can also opt to “make and sell” if they can sell emission permits thanks to their internal upgrades. Alternatively, they can “make and buy” (i.e., couple risk shifting with internal upgrades).

Tactic. Finally, the literature discussed several adaptation implementation tactics—that is, what kinds of specific changes businesses introduce in response to CC. These tactics vary widely by industry, as we further elaborate below in our discussion of industry-level determinants. Depending on the most likely internal functions to change, one may distinguish between commercial adaptation, technological adaptation, financial adaptation, and informational adaptation (Berkhout et al., 2006; Dingle and Stewart, 2018). Considering the perception of CC (as an opportunity or threat) and the scope of impacts (organizational or “institutional”), one may distinguish between “conservative” strategies to shift and share risks at the system level (connected to the *locus* dimension discussed above), “pragmatic” strategies such as (internal) portfolio diversification, “visionary” strategies leading to the development of novel initiatives with the stakeholders, and “explorative” strategies to improve internal efficiency and nurture resilience (Gasbarro et al., 2016).

3.2. Adaptation determinants

Several determinants of adaptation strategies were isolated through

⁸ Geographically, socially, or temporally proximate signals are most likely to prompt adaptive responses because it is most probable that they are understood as concrete risks (Craig, 2019). Some entrepreneurs might instead view CC as too abstract to accommodate *ad hoc* business strategies (Roman et al., 2010).

⁹ Subtle differences have been described between the anticipatory and the proactive varieties. Anticipatory adaptation (Busch, 2011) focuses on developing contingency plans for climate-related events, which, however, might be of limited use given the radical uncertainty associated with CC (Linnenluecke et al., 2012), leaving companies at the mercy of unpredictable manifestations of CC (Winn et al., 2011). Pro-active adaptation focuses instead on corporate identity and an organization’s ability to devise creative responses in the face of uncertainty (Beermann, 2011) and pursue CC-related opportunities (Wissman-Weber and Levy, 2018).

our inductive work of synthesis. These determinants can be straightforwardly arranged into four levels of analysis: individual, organizational, inter-organizational, and macro. Two determinants (*regulatory and stakeholder pressures, industry specificities*) describe institutional factors and industry considerations that largely lie beyond individual businesses’ control. These factors are at the macro level from the point of view of businesses involved in strategic decision-making vis-à-vis CC. One determinant (*business network features*) operates at the inter-organizational level and often requires coordination with other businesses. The *organizational capabilities* determinant operates at the organizational level. Finally, we report on *individual characteristics*.

3.2.1. Regulatory and stakeholder pressures

The ability to engage stakeholders, including regulators, in participating in regulatory mechanisms and advocating for amplifying CC risks and the urgency of adaptation at all levels was reported as being particularly relevant to adaptation strategies (see, e.g., Loehr, 2020; Martin & Rice, 2010). Stakeholder salience factors (power, legitimacy, urgency, and proximity) influence the perceptions of the impacts of CC, an element that was stressed particularly in the context of the wine industry (Galbreath, 2014). The willingness of stakeholders to partake in the adaptation process facilitates businesses in initiating change (Csete and Szécsi, 2015; Lopes de Sousa Jabbour et al., 2020).

Several authors noticed that businesses adapt to CC mostly to avoid regulatory scrutiny and reputation losses (Furlan Alves et al., 2019; Kouloukoui et al., 2019) and that the lack of formal regulations mandating adaptation measures might incentivize a wait-and-see approach (De Jongh and Möllmann, 2014; Wissman-Weber and Levy, 2018). However, coercive pressure might be less effective than pressure from imitating successful competitors and professional standards in prompting proactive (rather than reactive) measures (Daddi et al., 2020; Tisch and Galbreath, 2018).

3.2.2. Industry specificities

CC adaptation strategies materialized in every industry through a different set of actions. Most of the empirical research on CC adaptation published so far focuses on specific industries, mostly those most vulnerable to CC manifestations.¹⁰ Indeed, winter tourism, insurance, and wine are the industries most scrutinized so far in the literature. We found that these three industries, which share little in terms of the resources and capabilities required for climate resilience, experience CC in unique manners. In the winter tourism industry, CC poses well-documented threats to profitability and the long-term viability of operations (Scott et al., 2006), albeit not uniformly (Bhandari et al., 2016; Scott et al., 2021). Adaptive capacity has exceeded expectations as establishments have implemented snowmaking (an adaptation strategy that has attracted intense scrutiny in the literature; e.g., Steiger et al., 2019) and other innovations in the marketing mix.

Insurance is another industry in which CC effects were scrutinized (Mills, 2009; Stechemesser et al., 2015), in terms of both the impact of CC on this industry’s profitability and the role that insurers have in supporting other companies that “buy” adaptation (see the discussion above on the *locus* of adaptation). Through their policy terms and premium choices, insurers might be uniquely capable of jointly incentivizing the adoption of adaptation and mitigation measures (Herweijer et al., 2009).

The multidisciplinary wine-making literature documented various responses to CC, depending on geography and quality levels (see

¹⁰ The relationship between vulnerability and adaptive response might not be linear. Rivera and Clement (2019) found that protective adaptation is most likely at intermediate levels of vulnerability (an “inverted U-shaped relationship,” p. 1286). The reasoning is that low levels of vulnerability might not be enough to prompt an adaptive response, while high levels of vulnerability might undermine agency.

Ashenfelter and Storchmann, 2016). Evidence regarding this industry in our sample of papers came almost exclusively from Australia, where wine producers are proximate to the effects of CC yet do not experience its power, legitimacy, or urgency because of the perception that wine-making becomes “easier” with warmer temperatures (Galbreath, 2014, p. 96). The “winners of CC” perspective was uncommon in our collection of records.¹¹

3.2.3. Business network features

At the inter-organizational level, studies highlighted that tapping into the resources and capabilities of a broader network might be a conduit for adaptation (Galbreath, 2015; Tisch and Galbreath, 2018). Collaborations are most frequent at the municipal or regional levels (Pinkse and Kolk, 2012), although exceptions are communities of practice (Nicolletti et al., 2019; Orsato et al., 2019).

Supply chain collaborations deserve a specific discussion. The embeddedness of businesses into (global) value chains has implications for the adoption of adaptive practices (see, e.g., Lei et al., 2017), especially in sectors such as agri-food (Touboulic et al., 2018), automotive, chemical, mining, and electronics (Pinkse and Kolk, 2012), in which the success of a (downstream) company’s environmental commitments relies on the degree of commitment upstream to the same agenda (Mukhovi et al., 2020).

3.2.4. Organizational capabilities

A recurrent theme addressed within our sample of papers was organizational-level capabilities. Three organizational capabilities are considered relevant conduits for undertaking adaptive responses (Busch, 2011): i) the capability to absorb climate-related knowledge (see also Schmitt and Klarner, 2015); ii) the capability to reshape operational routines (e.g., greater flexibility in the supply chain; see also Herrmann and Guenther, 2017); and iii) the capability for strategic climate integration (a planned repositioning in light of climate disruptions; see also Gasbarro et al., 2016; Wissman-Weber and Levy, 2018).

Sensemaking is strictly connected to the capability to absorb climate-related information and might explain differences in CC awareness and, indirectly, adaptation responses (Hoffmann et al., 2009; Pinkse & Gasbarro, 2019). Sensemaking was defined by Tisch and Galbreath (2018, and references cited therein) as “a process whereby organizational actors attach meaning to external events to resolve the uncertainty surrounding them” (p. 2). Low levels of adaptation may be traced back to affirming existing “sensemaking structures and associated identities” (Harries et al., 2018, p. 712). Revisions in existing sensemaking structures are prompted by ontological shocks—that is, large-scale events that put pressure on existing sensemaking structures (Harries et al., 2018).

Businesses maintain a competitive advantage amid CC-induced changes by assembling and updating valuable, scarce, and hard-to-imitate resources (see, e.g., Barth and Melin, 2018; McDonald et al., 2014, p. 214). In contrast, the inability to command suitable resources was identified as a barrier to adaptation (Herrmann and Guenther, 2017). The approach of these authors resonates with an insight advanced in an early seminal contribution (Berkhout et al., 2006)—namely that the logic of “CC strategy” is no different from “ordinary strategy” at the level of individual businesses.

3.2.5. Individual characteristics

Empirical studies suggested that individual-level characteristics, often included as controls in studies whose main aim was not to uncover individual correlates of adaptation behaviors, might also influence the probability that businesses implement adaptation strategies. The role of entrepreneurs, in particular—their perception of CC, lifestyle, and

outlook—was addressed in the research (Brouder and Lundmark, 2011; Tervo-Kankare, 2019). Among other factors, the age of entrepreneurs was found to negatively correlate with adaptation choices (Bremer and Linnenluecke, 2017; Wongnaa and Babu, 2020)

3.3. Adaptation impacts

The *impact* of adaptation strategies was the least addressed aspect of the adaptation problem in the literature. In some cases, it was discussed in its temporal dimension, when it was linked to assessing the long-versus short-term consequences of adaptation strategies (Gasbarro et al., 2016; Schmitt and Klarner, 2015). Some advocated incorporating spatial and temporal scales into organizational adaptation theories (DiBella, 2020; Howard-Grenville and Lahnenman, 2021). Another issue occasionally addressed concerned the multifaceted dimensions of impacts. Some advocated monitoring adaptation’s environmental, social, economic, and financial impacts (Hopkins, 2014; Michailidou et al., 2016), while Howard-Grenville and Lahnenman (2022) lamented that the extant literature rarely considers the biophysical environment as a component of an organization’s external environment. Several authors pointed out the importance of adopting a systems perspective to the identification of impacts (Csete and Szécsi, 2015; Howard-Grenville and Lahnenman, 2021).¹² This systems approach could lead to large-scale entrainment, aligning adaptation efforts along the supply chain (see DiBella, 2020; Schmitt and Klarner, 2015).

Our analysis showed a dearth of tools for assessing the impact of adaptation strategies from multiple angles. The result of this gap is that no established methods have emerged to help practitioners and policy-makers assess whether adaptation produces long-term value (or turns into “maladaptation”) and to whom value accrues (along the triple bottom line). Furthermore, we currently lack methods of assessing whether adaptation strategies increase the resilience of the entire chain of value-adding activities into which each business is inserted or reduce vulnerability only for certain segments. We return to such concerns in the following section.

4. Discussion

Leveraging the results of our analysis of scholarly work on CC adaptation strategies at the business level, we propose an original framework that connects in different manners all layers of the synthesis that has emerged—namely, the novel multidimensional classification of adaptation strategies, the different determinants of adaptation, and the (currently underrepresented) dimension of the impacts. By appropriately rearranging these three layers, we can suit the diverse needs of the diverse audiences of our inquiry—that is, scholars, practitioners, and policymakers.

The first arrangement of our framework is shown in Fig. 2, and it speaks to scholars. It highlights areas of research that are currently underdeveloped to support further theorizing in the realm of CC adaptation strategies. The extant literature rarely establishes links between *specific* determinants and *specific* features of adaptation strategies—the dashed arrows from *Determinants* to *Classification* in Fig. 2. Research also rarely links adaptation strategies and their impacts—the dashed arrows from *Classification* to *Impacts* in Fig. 2.

4.1. Determinants: research gaps and future directions

Individual Level. The individual level appears particularly fertile for future scholarship to pursue. It is especially striking that there is a lack of papers discussing how biases and heuristics impact adaptation choices. These biases can include inconsistencies in time preferences (Laibson, 1997) and nonstandard risk and ambiguity attitudes (Wakker, 2010).

¹¹ Exceptions can be found in Demiroglu et al. (2018, p. 425), discussing “climate change tourism,” and Kutzner (2019).

¹² See also the review by Williams et al. (2017).

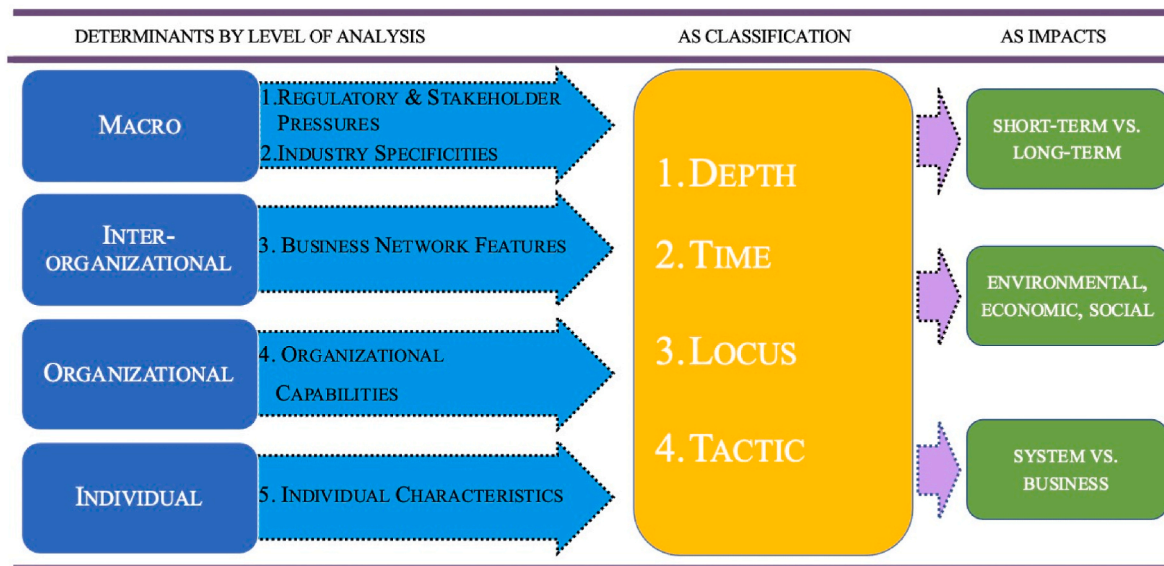


Fig. 2. A systematization of business adaptation strategies (AS) into three layers (determinants, classification, impacts). Dashed arrows represent research gaps in the current literature.

Learning from behavioral sciences may also clarify the reasons for resistance to updating beliefs in the face of mounting CC evidence, examining the “politicization” of climate science and its increasingly partisan associations at the corporate level (see, e.g., Haigh and Griffiths, 2012; Minucci, 2016).

Organizational Level. The organizational level of analysis has been associated with the literature on adaptation strategies since the pioneering early contribution by Berkhout et al. (2006). Still, research gaps exist. For instance, it is ambiguous in the extant literature whether increasing the frequency of extreme events at the organizational level favors the routinization of adaptation and the development of dynamic capabilities, ultimately leading to a “continuous” type of adaptation (Gasbarro and Pinkse, 2016) and resilience-building (Rivera and Clement, 2019) or whether frequent exposure to CC manifestations leads to a loss of competitive advantage because of sustained climate-related damages eroding a business’s fundamentals (see, e.g., Kutzner, 2019).

Inter-Organizational Level. Few papers have so far focused on inter-organizational dynamics. Future scholarship might investigate the conditions under which resources and capabilities can be most effectively shared upstream and downstream in the supply chain, thereby reducing the vulnerability of the entire chain from a system perspective. The adaptation choices of multinational businesses are likely affected by such systemic considerations, since they rely on suppliers located in parts of the world where the exposure risk to CC is high and the adaptive capacity low.¹³ A new tradeoff between labor arbitrage opportunities in the Global South and climate resilience is emerging—a phenomenon deserving further study. More generally, the joint study of adaptation and global strategies promises to be fertile ground for future research. We expect the topic of systemic adaptation to gain traction in the aftermath of the new *European Sustainability Reporting Standards* drafted by EFRAG (a technical body supporting the European Commission) in support of the *Corporate Sustainability Reporting Directive* (Directive (EU) 2022/2464). These new standards require large European companies to disclose indirect (or “scope-3”) emissions, including those originating

¹³ The fact that many of the world’s most vulnerable countries are also low in terms of adaptive capacity is discussed in a recent IMF article, available at <http://www.imf.org/en/Blogs/Articles/2022/03/23/blog032322-poor-and-vulnerable-countries-need-support-to-adapt-to-climate-change> (last retrieved: June 15, 2023).

outside the European market, which will be subject to the new Carbon-Border Adjustment Mechanism (see Bellora and Fontagné, 2023).

Macro Level. As for the macro level, it seems particularly urgent for scholars to address a more diverse set of industries. It is especially puzzling that many so-called “hard to abate” industries, such as oil and gas, made sporadic appearances in the sample of papers we analyzed (e.g., Gasbarro and Pinkse, 2016). The industry that has attracted the most attention so far, winter tourism (the “canary in the coalmine” of adaptation scholarship, as Bicknell and Mcmanus, 2006 called it), is *sui generis*. This industry has, in fact, managed to adapt to climate-related snowpack uncertainty thanks to a technical innovation (snowmaking) that dates back to the 1930s¹⁴ and to diversification (Demiroglu et al., 2018; Huynh and Piracha, 2019). Insurance and wine-making are also highly peculiar, as shown above. Reporting evidence from different industries, and providing comparisons among them, might allow a faster generalizability of good practices among different organizations and a strengthening of the evidence emerging from scholarly publications.

Cross-Levels. Future scholarship might further address overlaps across determinants at different levels. Lopes de Sousa Jabbour et al. (2020) provided an example of how this might be done. The authors discussed three scenarios—companies might choose 1. not to act (the *time* criterion we discussed under our classification), 2. to weaken barriers by seeking the cooperation of stakeholders (the *regulatory and stakeholder pressures* determinant), or 3. to nurture the required capabilities to deal with climate change (the *organizational capabilities* determinant). They proposed bringing different levels of analysis together—“coordinate stakeholders, resources, and capabilities to meet the challenges and opportunities arising from climate change” (p. 20).

4.2. Determinants and classification: research gaps and future directions

In most cases, the literature on adaptation determinants discussed adaptation strategies in broadly constructed terms. Yet, it is essential to understand which determinants are most likely to affect the probability that one specific kind of adaptation strategy will emerge. Bremer and

¹⁴ For a detailed reconstruction of the birth of this technology, see <https://www.smithsonianmag.com/arts-culture/how-artificial-snow-was-invented-180973334/#:~:text=technical%20director%20Louis%20Geib%20had,resulting%20particles%20into%20the%20air> (last retrieved: June 25, 2023).

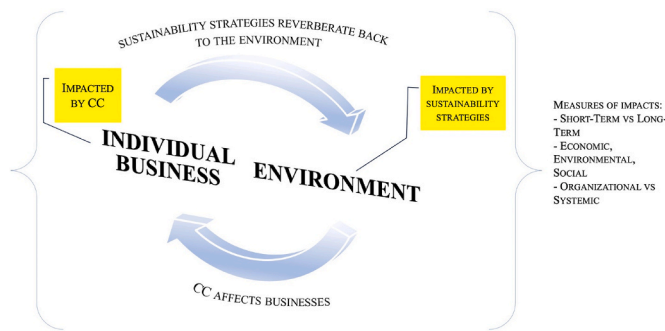


Fig. 3. The symbiosis between business adaptation and the context where it is embedded.

Linnenluecke (2017) claimed that the inability to assess the impact of CC on an organization would likely lead to maladaptation or no adaptation. Indeed, attempts were often made to establish a relationship between one or more determinants and the adaptation versus no adaptation choice. Nevertheless, relations between determinants and the specific features and dimensions along which adaptation strategies can be classified remain poorly understood. Awareness and vulnerability were found to affect the *time* (Gasbarro and Pinkse, 2016), *tactic*, and *locus* (Pinkse & Gasbarro, 2019) of adaptation strategies—a significant exception.

A point that seems intuitive yet rarely made explicit (Gasbarro et al., 2016, is an exception) is that the absence of organizational capabilities for adaptation might lead to risk shifting, placing the *locus* of adaptation outside an organization's boundaries.

Rich links remain to be drawn between the organizational and inter-organizational levels and the specific adaptation *tactic*. It is also likely that individual-level variables such as time and risk attitudes and the level of perceived agency vis-à-vis CC affect the *time* and *depth* of adaptation. Elaborating on such connections represents a future task in adaptation scholarship.

4.3. From classification to impacts (and back): research gaps and tools for practitioners and policymakers

As highlighted above, the impact of adaptation strategies is one of the most overlooked aspects in the business literature on adaptation strategies. The result of this gap is that we are left with a broad—we would argue too broad—understanding of the term *maladaptation*. If the main objective of adaptation strategies is to decrease (actual or perceived) vulnerabilities to climate change and bolster resilience, there is no guarantee that this objective will be fulfilled. The inability of adaptation strategies to create long-term value for a business might be viewed (*ex-post*) as an example of maladaptation. However, negative social, environmental, and systemic externalities can also be considered kinds of maladaptation. *Success*, when discussing CC-related initiatives, is not an “objective” fact (De Bakker et al., 2019, p. 366). Rather, success likely depends on the need for legitimacy (Meyer and Rowan, 1977) of the actors involved in adaptation strategies and considerations related to the types of strategies available. The success of adaptation strategies is, therefore, influenced by the context within which these decisions are made and the impacts these choices have.

In particular, our review showed that few studies devoted significant attention to the symbiotic relationship between adaptation and the context into which organizations are embedded, incorporating time, economic, social, environmental, and systemic considerations (see Fig. 3). We propose that evaluating the success or failure of adaptation strategies necessitates the following three distinct outlooks: 1) comparing short versus long-term impacts, 2) a triple-bottom-line perspective, and 3) a system perspective. Despite being seldom nurtured and never jointly addressed, the three perspectives exist in the

literature (see Section 3.3).

One of the tangible results of this gap in impact accounting is that the managerial decision-making process on adaptation lacks a strong foundation on *outcomes*, with likely implications for long-term value creation. Similarly, policymakers lack solid tools to steer the business economy's adaptation trajectory toward social and environmental welfare. By nudging all interested parties toward *impact-aware adaptation strategies*, we can maximize the chances of a nondecreasing portfolio of adaptation choices across time and space.¹⁵ Such strategies are valuable for business leaders alert to the need for sustainable value creation. They promote intergenerational equity, for they incorporate physical–environment impact assessment into the formulation of current adaptation strategies. They build social consensus around business adaptation choices, an issue particularly felt in mountain communities proximate to ski resorts (Steiger & Abegg, 2013). Finally, they ensure that companies effectively contribute to the broad climate-resilience agenda set by national and supranational organizations.

We can leverage a different arrangement of our three-tier framework to outline a “reverse roadmap” that will help practitioners and policymakers craft adaptation strategies. This workflow is shown in Fig. 4. It starts by defining which impacts are desirable as an outcome of adaptation (for example, a reduction in drought risks for an agri-food business).¹⁶ Policymakers are likely interested in ensuring that the current adaptation choices do not produce long-term costs, particularly of the social and environmental kinds that restrict future policy options (for example, ensuring new practices that will address water scarcity in the agricultural sector will not jeopardize the wellbeing of communities living nearby, or resulting in more water scarcity in the future). On their side, practitioners are likely interested in increasing the resilience of the system in which they operate (i.e., ensuring the long-term viability of farms located in dry areas). In the following step, practitioners engineer the *depth*, *time*, *locus*, and *tactic* of adaptation, and policymakers impose constraints on those same dimensions. In so doing, policymakers and practitioners can avail themselves of the evidence we have presented regarding the facilitators of and barriers to adaptation (the determinants level). Provided that economic, social, environmental, and systemic damages have been excluded from the set of acceptable impacts, the adaptation strategies that ensue will be an effective guard against all forms of maladaptation and lead to the creation of “advanced resilience capabilities” in the face of CC (Rivera and Clement, 2019, p. 1289).

5. Conclusion

Despite the increasing interest of scholars, practitioners, and policymakers in ensuring organizations effectively adapt to CC and become actors of transformation toward sustainable development, knowledge on adaptation strategies to CC at the business level is scattered and urgently in need of systematization. Based on a systematic literature review, we provided a multidimensional classification of adaptation strategies, which enabled us to nuance the understanding of adaptation strategies according to *depth*, *time*, *locus*, and *tactic*. Furthermore, we identified what are the recurrent adaptation determinants that are associated with the implementation of adaptation strategies (versus inaction or maladaptation), pinpointing relevant factors at the individual, organizational, inter-organizational, and macro levels. Finally, we systematized the current knowledge on the impacts of adaptation strategies (the least

¹⁵ In their classic text, Cyert and March (1963) made this point, although obviously not in the context of climate change adaptation decisions.

¹⁶ An example of the trade-offs arising in climate adaptation, and of the long-term negative consequences of misguided adaptation, comes from the Doñana wetlands in Spain. Here, the water essential to preserve biodiversity clashes with the water demands of the surrounding strawberry fields. See <https://www.theguardian.com/world/2023/dec/27/spain-environment-minister-hails-anda-lucia-wetlands-deal-green-transition> (last retrieved: December 28, 2023).

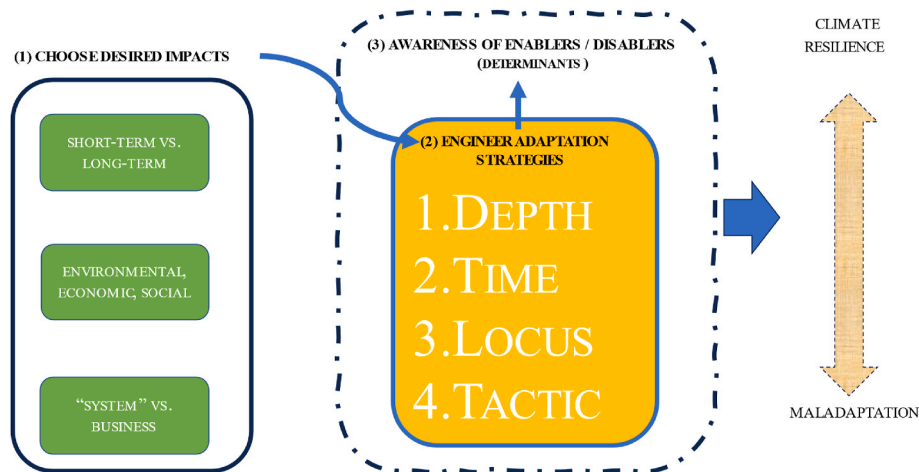


Fig. 4. A reverse roadmap for policymakers and practitioners.

addressed aspect in the current literature), advocating for impact-aware adaptation strategies, i.e., a kind of adaptation that considers the long-term implications of adaptation, the ability of adaptation strategies to “climate-proof” the entire value chain, and the type of impacts produced along the triple bottom line. We proposed a three-tiered framework that connects types of strategies, determinants, and outcomes. Its versatility allows for the identification of research gaps and supports policymakers and practitioners in their varied decision-making roles.

Our study is not without limitations, primarily related to the material and methods employed. Specifically, restricting our search to academic publications within the business field may have caused us to overlook valuable insights from related disciplines or non-academic sources. Future research should consider expanding the search criteria to enhance coverage and draw from interdisciplinary insights, which could provide a more holistic understanding of business adaptation strategies. Additionally, the specific choice of keywords in our query may have unintentionally excluded relevant studies on business-level climate strategies that did not explicitly use those terms in their titles, abstracts, or keywords. Some relevant studies may have been unintentionally excluded due to these terminological and methodological choices. An instance is a paper by Paul et al. (2017), which employs a multilevel approach to assessing business strategies for climate change. Moreover, due to the particularly lengthy editorial process, a few newer studies that fall outside the temporal scope of our data collection were not included (e.g., Lindbergh et al., 2022; Ponce Oliva et al., 2022). We recommend that future research incorporate these recent contributions. The exclusion of certain studies due to terminological choices, methodological constraints, or the publication timeline has created potential gaps in our analysis. Furthermore, while our study offers a comprehensive framework for adaptation strategies at the business level, future scholarship could focus on deepening the analysis of strategic tools for climate management (Pesonen and Horn, 2014).

In conclusion, we return to the consideration of Linnenluecke et al. (2013) that the literature on adaptation at the time of their review was “sparse.” We submit that the literature on this topic shall be “sparse no more.” We hope this review, despite its limitations, serves to invite further research into the effective and equitable management of climate-related risks and resilience building in the face of CC.

CRedit authorship contribution statement

Giuseppe Danese: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Valentina De Marchi:** Writing – review & editing, Writing – original draft, Validation, Supervision, Project administration, Formal analysis,

Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jclepro.2024.144322>.

Data availability

No data was used for the research described in the article.

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