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Towards a standardized tool for improving the mainstreaming of climate change adaptation in Moroccan private companies

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Abstract Climate change (CC) represents new and unprecedented challenges for businesses and is now viewed as a new business imperative. Unlike large multinationals, Small and Medium Enterprises (SMEs) are particularly vulnerable to climatic hazards, and often lack flexibility in the distribution of their risks. To preserve their business and sustainably strengthen their resilience and competitive advantages, SMEs must now systematically integrate adaptation to the impacts of CC in their business strategies and the various links in their value chain. Therefore, it is necessary to provide them with appropriate methodological tools dedicated to the assessment of their vulnerabilities and risks and the development of CC resilience strategies. Using an optimized approach to Moroccan SMEs, this research work provides a sequential flowchart to characterize and prioritize climate risks, identify potential business opportunities, and develop a coherent strategy to adapt to climate change, integrated with the Greenhouse Gas mitigation process. The development of this flowchart was guided by the results of the evaluation of the implementation of the Climate Expert tool to help analyze climate risks and opportunities- with several Moroccan companies and the benchmark of the instruments for screening and evaluating climate risks relevant to the Moroccan business context. Consequently, three main areas of impact have been identified, covering the company's core operations, the value chain and the external environment. Later, this flowchart will serve as the basis for developing an online tool for managers to assess vulnerability to climate risks at the scale of their companies and to identify and prioritize adaptation measures.

Keywords: adaptation to climate change, resilience; small and medium enterprises, risk assessment, tool.

1. Introduction

In its New Development Model (NDM), Morocco evolved its national economy into a more diversified and competitive economy driven by a dense fabric of innovative and resilient companies (CSMD 2021). However, climate change (CC) poses a significant threat to the economic development of Morocco and other African countries. In the coming years, a slowdown in growth and development is expected to be a direct consequence of exacerbating climate impacts, coupled with a deficit in CC adaptation (IPCC 2022b). The widening of this deficit inevitably increases losses and vulnerabilities, with substantial risks for development under any scenario of greenhouse gas (GHG) emissions (IPCC 2022b).

Companies now face a range of risks, including increased physical risks. These risks are accompanied by a disruption in the company's development model, which is forced to mitigate GHG emissions and adapt to the impact of CC (Sanderson et al. 2017).

Morocco is highly vulnerable to climatic variability and CC. Its vulnerability has been exacerbated by the increasing incidence, severity, and duration of drought, decreasing precipitation, and increasing temperatures, coupled with the pressures of population growth, rapid urbanization, and ambitions for industrial development. The impacts of CC are particularly acute in the country's water, agriculture, and health sectors (MTEDD 2021a; World Bank Group 2021). Additionally, the rise in sea level could affect a large part of the country's coastline, spread over 3500 km, where most Moroccan industries and companies are located.

Although CC is the most impactful global risk for many multinational companies (WEF 2021), there is a great mismatch between the strategies of companies and the announced scale of the CC challenge. Regarding CC adaptation strategies, private companies often underestimate the impact of climate risks on their activities (Atela, Gannon, and Crick 2018; Forino and von Meding 2021; Goldstein et al. 2019). This mainly concerns physical risks related to CC, the lack of consideration of supply chain risks, and the tendency to focus on "soft" and "hard" adaptation strategies (Goldstein 2020; Goldstein et al.

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2019). Given the commitments of the Paris Agreement, there is an urgent need to develop robust assessment tools for companies regarding climate risks and to explore the social and economic impacts of the CC (Sanderson et al. 2019).

To fill this gap, (Sanderson et al. 2019) emphasized the need to support efforts to standardize approaches to climate risk assessment, including the establishment of methods and the provision of accessible business tools. This requires that companies particularly exposed to climate risks be part of a systematic and conscious process of knowledge transfer between business communities and policymakers (Ingirige and Wedawatta 2014).

Regardless of the uncertainty inherent in the magnitude and impact of CC, several risk analysis and decision support tools have been applied in various contexts. However, the usefulness and relevance of these tools are not yet fully understood (New et al. 2022). (Brooks et al. 2014) stressed the importance of using integrated assessment models, including key exogenous variables, interactions between the expected effects, and the trajectory of the CC in perspective with uncertain variables.

The choice among these analytical tools is often influenced by the cognitive requirements of the decision-making phase, the level of uncertainty surrounding the choices, and their context. Thus, the main purpose of the cognitive phase is to give meaning, model, explore, and analyze existing data and information, and interpret and prepare for the implementation of adaptation actions (New et al. 2022; Richards et al. 2013). Hence, the importance of providing business leaders with standardized tools enables them to conduct an anticipative analysis of climate-related risks and plan, finance, and implement risk management measures.

In a nutshell, integrating adaptation to climate change is still a key component of Morocco's climate policy and new development model. In contrast to the progress made in mitigation, the integration of adaptation is struggling to find its way into the business world, especially among SMEs, implementing resilience and adaptation can seem abstract and complicated. The central question we might ask is: How can Moroccan SMEs be urged to adopt balanced resilience strategies? Can we come up with a tool that is both easy to use and relevant to promote the understanding and anchoring of adaptation in companies?

Building on previous research on the state of play and prospects for integrating adaptation into Moroccan businesses (Jaouhari, Stour, and Agoumi 2021a, 2023b), this study provides an optimized tool for assessing climate risks and developing resilience strategies. This tool was developed in three successive stages. As a first step, a literature review was conducted on the evaluation reports about twenty Moroccan companies using the Climate Expert (EC) tool (Jaouhari, Stour, and Agoumi 2021a).

Then, a participatory process for the improvement of this tool is conducted with executives and technical managers of companies, as well as a group of CE evaluators. Finally, the results of these first two steps were enriched by conducting an analysis comparing two other climate risk assessment tools dedicated to companies (The Business ADAPT tool and the BACLIAT tool), which have developed in distinct contexts. This analysis identifies aspects relevant to the local business context and the needs of Moroccan small and medium-sized enterprises (SMEs).

Thus, the outputs of this improvement process were used to develop an optimized flowchart for SMEs to assess their vulnerabilities and risks related to CC and to implement a proactive resilience strategy combining adaptation and mitigation approaches.

2. Literature review

2.1. Exposure of SMEs to climatic hazards

Through their important role in the national economy, SMEs contribute significantly to job creation and value chains in Morocco (HCP 2019). Nevertheless, these SMEs generally operate in low value-added sectors such as real estate, trade, and various services (MTEDD 2021a). A significant proportion of Moroccan SMEs operates in the informal sector. This reduces their access to finance, new market opportunities, and public sector services (HCP 2016). Their technical and financial capacities are often insufficient to respond to climate risks and disasters, and are, therefore, disproportionately more vulnerable to the effects of CC (Schaer 2018).

Moreover, unlike large multinationals, SMEs often operate on a local scale and are therefore particularly exposed to climatic hazards, with little room for maneuver in terms of spreading their risks. Their activity is highly exposed to climatic extremes, often because of their location in dangerous and unequipped areas (IPCC 2022b).

A series of recent studies (CGEM 2019; GIZ 2017; Jaouhari, Stour, and Agoumi 2021b; MTEDD 2021a) agree on a set of proven impacts and potential risks induced by CC affecting Moroccan firms at different levels but in a differentiated manner. These impacts depend on many factors such as size, location, and industry type. These are as follows:

- Low availability of natural resources, particularly water.
- Volatility of energy or raw material prices
- Disruption of supply chains, logistics, and transportation systems
- Decreased effectiveness and efficiency of production processes
- Increased insurance premiums and withdrawal of risk coverage by insurers

- Consequences due to the degradation of infrastructure
- Health problems affecting workers and consumers...

2.2. The imperative of mainstreaming adaptation to Moroccan businesses

In terms of climate action, a company is called upon to integrate the effects of CC into its business policy. It is expected to make a substantial effort to reduce GHG emissions from emitting sectors without losing sight of the need to strengthen its adaptation and resilience to CC-related consequences. In this view, adaptation is seen as an additional element of business risk management, a key to increasing competitiveness, or an opportunity for companies to develop new products and services (GIZ 2017; Schaer 2018). However, similar to other developing countries, Moroccan firms are already investing in adaptation measures without identifying them as such. Evaluations conducted among these companies have shown that almost all of the adaptation measures undertaken concern the production process or meeting and anticipating environmental regulations (Jaouhari, Stour, and Agoumi 2021a).

Adaptation represents an opportunity to innovate and create a new flow of business as emerging markets in new energy technologies and other low carbon-intensive products and services (Sharma 2016). Generally, Moroccan SMEs focus almost exclusively on the competitive advantages of controlling production costs and anticipating new environmental regulations, instead of developing or having developed specific technologies in response to climate challenges (Jaouhari, Stour, and Agoumi 2021b).

2.3. Corporate climate risk management

Risk management includes planning, actions, or policies implemented to reduce the likelihood and/or consequences of risks or respond to consequences (IPCC 2014). Instead of being viewed as a company's safety net, risk management is becoming a key business function with strategic influence. By leveraging existing data processing and analytics capabilities, risk assessment can become a fundamental tool for helping companies transition to resilience and growth.

According to the latest version of ISO 31000:2018 on risk management, risk assessment is a comprehensive process of risk identification, analysis, and assessment (Figure 1). It should be conducted in a systematic, iterative, and collaborative manner, drawing on the knowledge and opinions of stakeholders (ISO 2018a).

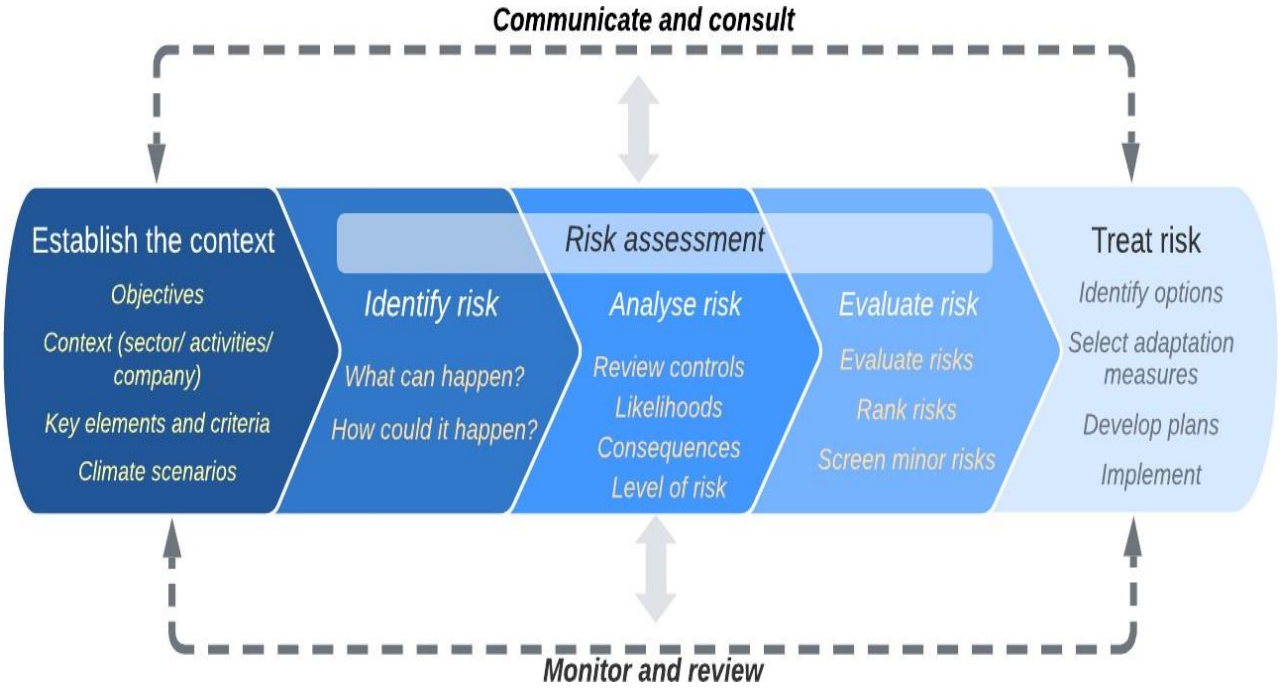

Figure 1 Steps in the risk management process (ISO 2018b) adapted and designed by the authors).

Methodologically, a myriad of tools has been developed to screen climate risks and the integration of adaptation. These tools are applied in various contexts and use distinct approaches (UNDP 2010a). However, the usefulness and relevance of these tools have not been fully proven (New et al. 2022), emphasizing the lack of a systematic method for quantifying climate risk and of quantitative decision-support tools for dealing with climate risk in a systematic and resource-efficient manner. In the absence of such tools, decisions tend to be based on perceived immediate climate threats, which often leads to a series of reactive and inconsistent adaptation measures.

3. Methods

3.1. Terminology clarification

The terms “resilience” and “adaptation” are often used interchangeably to address the CC threat. Resilience refers to the ability of a system to cope with a dangerous event, trend, or disruption, and to react or reorganize to maintain its essential function, identity, and structure (IPCC 2022c). Adaptation, on the other hand, includes a facet of resilience and deals with the process of adjusting to the present and expected climate and its consequences to mitigate its damaging effects and exploit its beneficial effects (IPCC 2022a).

Risk: In the context of CC, risks may arise from potential climate-related impacts and human response to CC. According to the Fifth Assessment Report (AR5) of the IPCC Working Group II (WGII), the concept of risk has become more similar to that of CC risk, based on risk assessment methods used in the disaster risk reduction community (Figure 2) (GIZ and EURAC 2017a; IPCC 2014).

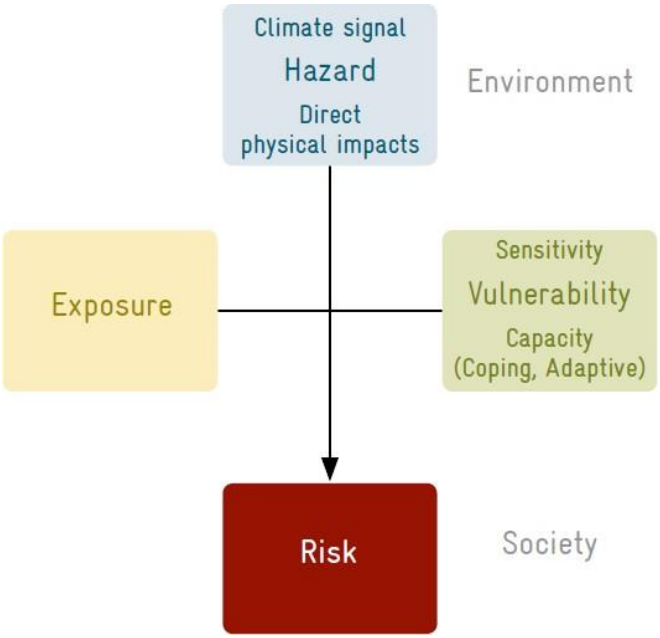

Figure 2 Components of climate risk (AR5) (GIZ and EURAC 2017b).

3.2. Methodological approach

In this work, the term "tool" refers to methods for screening and assessing climate risks, including structuring checklists and computer-based risk screening and assessment tools (Trærup and Olhoff 2011). Methodologically, the approach adopted was as follows (figure 3).

3.2.1. Literature review and benchmarking

This first step focused on identifying the success factors and potential barriers to CC adaptation in the national business context. It also serves to identify areas of impact and climate risks relevant to Moroccan businesses. Referring to existing methodological guides and compendiums (Secretariat-UNFCCC 2008; UNDP 2010b), a review of these documents allowed for a review of several screening and mainstreaming approaches and tools dedicated to businesses through case studies and various available information. Emphasis was placed on understanding the similarities and differences between these tools, their scope, and the ease or difficulty of deploying their methodologies. This facilitated the identification of relevant elements for Moroccan companies to feed on aspects to be optimized.

3.2.2. Climate Expert analysis

To assess the consistency and use of the CE tool, a questionnaire was distributed in June 2020 to evaluators who used this tool. The purpose of this step was to collect feedback on the deployment of the tool at the level of the companies examined to identify possible areas for improvement. The results of this survey were supported by an in-depth analysis of the evaluation reports of a sample of 20 Moroccan companies operating in the agribusiness and textile sectors (Jaouhari, Stour, and Agoumi 2021b). Following a strengthening organizational learning approach to adaptation, SWOT (Strengths,

Weaknesses, Opportunities, Threats) analysis was conducted. This analysis examined the intrinsic strengths and weaknesses of the CE tool, such as its control and consistency of steps, as well as the opportunities to promote its use and the threats that could affect its efficiency and contribution to the business.

Comparative analysis: Approaches to screening and analyzing climate risks are diverse and have an obvious richness in informing and guiding the integration of adaptation to CC, particularly within companies (New et al. 2022; UNDP 2010b). In this step, we analyzed two additional tools specific to private companies, namely: Business Adapt (Amado et al. 2012) and BACLIAT (Environment Agency 2012). The purpose of this analysis is to review the layout and consistency of the methodological steps of each tool, their impact areas and considered risks, and the entry points for integrating the outputs related to each step. The results of this review were used as input for the design of a flowchart for analyzing climate risks and developing a strategy for resilience to CC.

3.2.3. Improvement plan

This step explores the possibilities of improving the CE tool by considering the results of the above-mentioned comparative analysis and the needs expressed by the interviewed Moroccan business leaders. The proposed improvement plan lists the elements to be reviewed for each step and the relevant ways to ensure more fluidity and efficiency in the deployment of the tool in question.

3.2.4. Flowcharting

Step-by-step flowcharts help clarify procedures and allow for greater flexibility and speed in mapping different activities and tasks to be undertaken. They offer the possibility of significantly improving communication through complex procedures. In the business world, flowcharting is the most commonly used tool for analyzing and improving business and operational procedures (Nesbitt 1993). In relation to this research, the analysis of the structure of the three examined tools and the improvement points from the improvement plan formed the basis for developing the optimized flowchart. The flowchart is developed in the following sequence:

- Identifying the scope of the analysis and its phasing
- Identify the sub-steps and their chronological arrangements
- Organize each sub-step using the common flowchart symbology
- Create a flowchart using specialized software
- Review and verify the organization of the steps and sub-steps of the flowchart

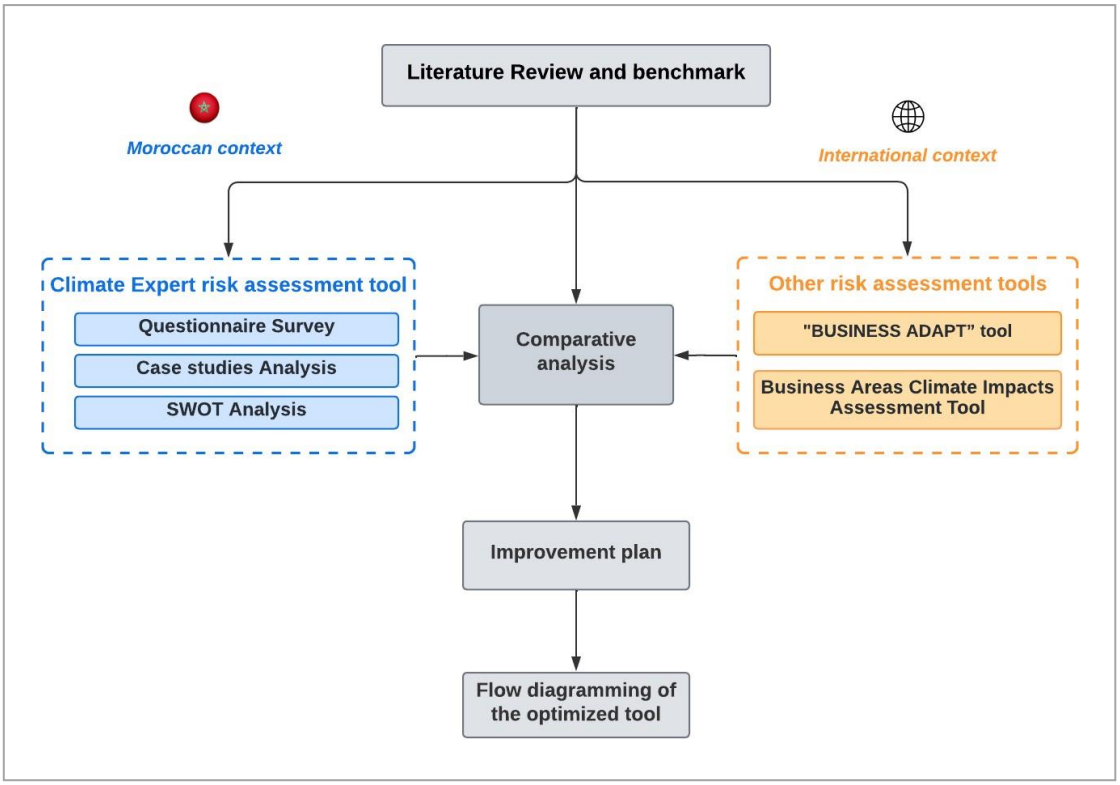

Figure 3 Deployment of the methodological approach.

4. Results and discussion

4.1. Prospects for optimizing the CE tool

Moroccan SMEs often operate in a climatic context that exposes them to a series of hazards and climatic extremes that vary according to business activity and sector. Their vulnerability is further exacerbated by the state of viability of industrial facilities and their location (Jaouhari, Stour, and Agoumi 2023a). As a result, Moroccan SMEs are subject to a range of potential direct and indirect impacts, from higher operating costs to business interruption. These impacts will affect buildings, infrastructure, production and inventories, employees, the supply chain, market demand, finance and insurance.

In this regard and in response to climate risks, the CE tool is a relevant tool for determining companies' vulnerability to CC, identifying their business opportunities and implementing efficient adaptation strategies. It also enables selected adaptation options to be prioritized using decision-support tools such as multi-criteria analysis and cost-benefit analysis. The CE tool has been used to conduct approximately twenty assessments of Moroccan companies in the textile and agrifood sectors in practice (Jaouhari, Stour, and Agoumi 2021b; Strasser and Mewes 2013). The focus group analysis conducted in our previous work (Jaouhari, Stour, and Agoumi 2021a, 2021b) identified ways to improve the CE process itself and highlighted accompanying measures to facilitate awareness and implementation of this process. For example, it is recommended to harmonize the CE approach with the GHG mitigation approach to achieve a common integrated strategy at the company level. Compared to the current version of the CE tool, improvements have also been proposed to optimize the CE to the business context and the needs of Moroccan companies, including the following:

- Simplification and clarification of the terminology and conceptual corpus used in accordance with the AR5 and AR6 conceptual frameworks.
- Development of present and future climate analysis on a scale relevant to the enterprise
- Consideration of the structure of the CE approach for aspects related to the financing of adaptation measures and their monitoring and evaluation.
- The use of a mixed procedural approach (bottom-up and top-down) that considers climate risk in all its dimensions (Conway et al. 2019) and allows an effective response to the real needs of immediate and urgent adaptation decisions.
- Adoption of a methodological approach with three distinct stages (initiation, evaluation, and implementation).

In relation to the deployment of the CE Tool steps, the following table 1 summarizes the main areas of improvement identified, as well as the resources required to ensure the optimization of the CE Assessment:

Table 1 Areas for improvement of CE tool.

Steps	Areas for improvement	Support to be provided
Preliminary step	• Define the reference year • Opportunity for the use of external expertise • The rapid assessment step is not entirely justified • Contextualization of analysis in relation to national and sectoral strategies and objectives in place of climate change	• Compendiums of methods and tools • Inventory of qualified climate experts • Alignment and integration of CE deployment and company GHG mitigation approach • Strategic, legal, and policy framework
Step 1 CC impacts	• Define a local climatic profile -based	• Local weather records, history of extreme weather events, and available trends and projections • Inventory of potential impacts and risks by the most vulnerable business sectors
Step 2 CC risk and opportunities	• Clarification and simplification of the conceptual framework of risk and vulnerability	• AR5 and AR6 Conceptual Frameworks (IPCC 2014, 2022b) • Risk and Vulnerability Sourcebook (GIZ and EURAC 2017b)
Step 3 CC adaptation measures	• Deeper Opportunity Assessment	• Detailed catalog of measures and good practices by sector of activity • Opportunity studies by industry
Step 4 CC adaptation strategy	• Integrated strategy combining adaptation and mitigation • Special resilience plans to address urgent risks • Integration of the monitoring and funding components in the implementation phase	• Inventory of techniques and technical and technological devices with high potential for climate protection

4.2. Comparative analysis with other risk assessment tools

Approaches to climate risk screening and analysis are diverse and have an obvious richness in informing and guiding the integration of CC adaptation, particularly within companies (UNDP 2010b). With a few differences, the approaches of the

three tools examined in this study are essentially inspired by the logic of risk assessment. The points of divergence depended mainly on the context and objectives that led to the development of each tool.

Regarding the Business ADAPT tool, the value chain approach focuses on the effects induced by CC across companies and national boundaries. Local communities and the natural environment are also considered because of their crucial role in business value chains (Amado et al. 2012). The deployment of each step of this tool was framed by guiding questions for company managers to address, among other things, the lack of globally approved standards for climate risk management. The time required to conduct such an approach primarily depends on the scope of the analysis.

BACLIAT is conducted using checklists to assess potential CC-related impacts. The proposed model was based on a non-exhaustive review conducted as a participatory brainstorming exercise. However, these checklists can also be used as simple guides to assess climate events and highlight aspects relevant to the business under review (Ingirige and Wedawatta 2014). The BACLIAT tool is also used as a general awareness resource for managers from various industries or as a scoping exercise with a group of employees from the same company or industry. Figure 4 provides an overview of the deployment and the major steps and sub-steps of the three tools.

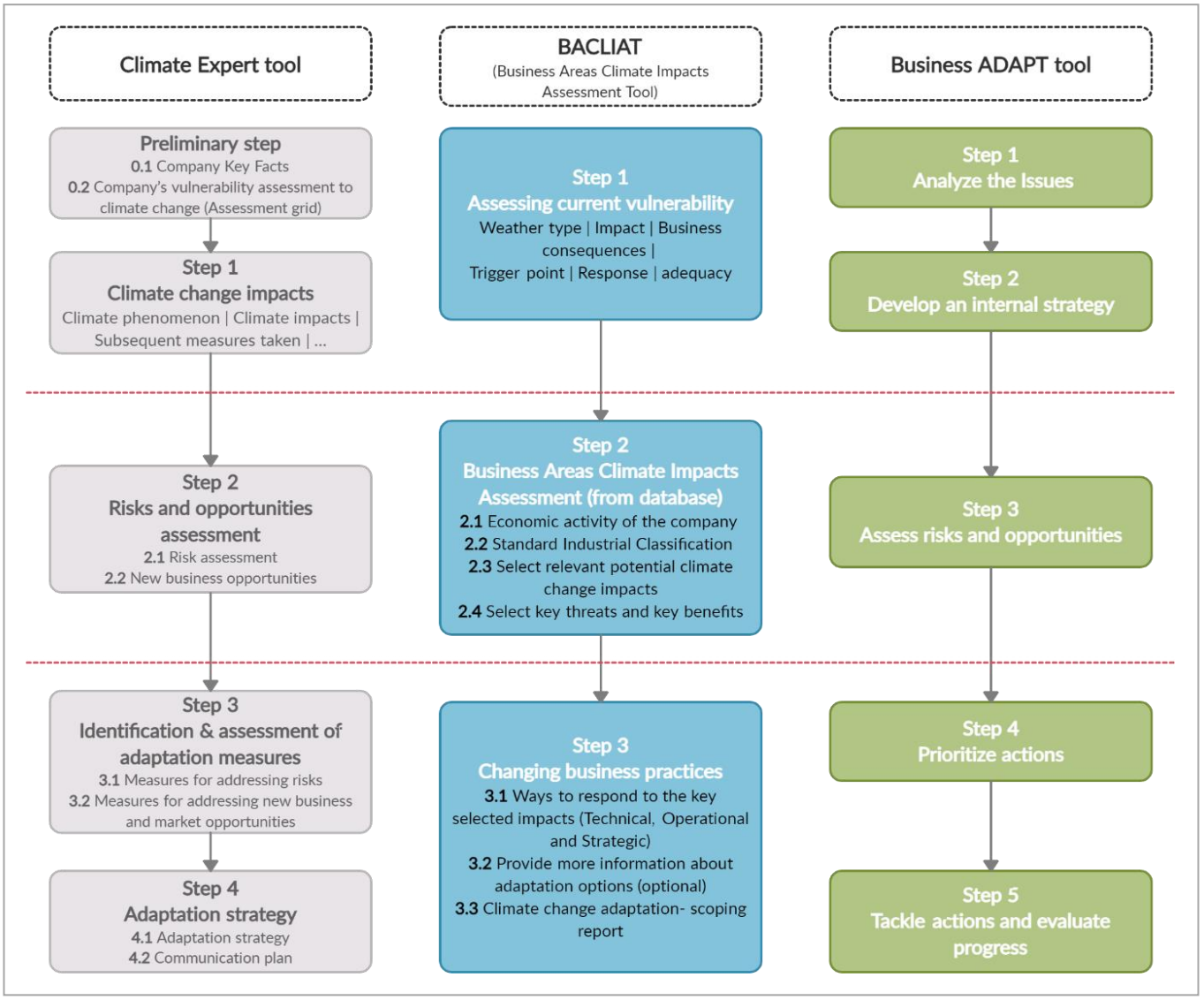

Figure 4 Comparison of the deployment steps of the three tools examined.

The comparative analysis of the above tools was based on a comparison grid that included elements related to the scope of the tool; its approach and use; the main inputs and outputs; and the prerequisites, cost, and time required to conduct the analysis. This analysis identified the relevance of these elements in the business context and the needs expressed by the Moroccan business leaders interviewed. The table 2 below summarizes the main elements that emerged from this analysis.

Table 2 Comparative analysis between the Business ADAPT tool and the BACLIAT tool.

	Business ADAPT (building Climate Resilience in Value Chains)	Business Areas Climate Impacts Assessment Tool (BACLIAT)
Scope	• Can be used for a large number of individual organizations and communities	• Used at the level of a single organization or an entire industrial sector
Approaches and use	• A value chain approach based on a five- step climate resilience framework	• Workshop-based process, can be used by an individual or a group • Used by several UK trade associations and professional bodies
Considered areas of impact	• Support resources and business environment (Access to finance, policy environment, and Stakeholder expectations) • Primary activities beyond business fencelines (Community and ecosystem resilience, raw materials sourcing, distribution, and sales) • Primary activities within business fencelines (assets and infrastructure, and production)	• Logistics • Finance • Markets • Process • People • Premises • Management implications
Key Input	• Proven knowledge of value -chain issues and the impact of recent and historic climate-related events on business • Involve those responsible for infrastructure management or business critical services, and those with valuable expertise or have critical data and information to assess risk	• Climate change scenarios and sufficient knowledge of the company and its sector of activity
Key output	• Impacts of climate change throughout the business value chain, possible opportunities, and measures to manage impacts • Entry points to integrate climate resilience considerations	• Inventory of potential climate impact on the company and its sector of activity
Prerequisites	• Do not need prior training or computer requirements. Links to examples and additional sectoral modules are provided, such: Food, Beverage, and Agriculture; Water and Energy Utilities; and General Manufacturing)	• Do not need prior training or computer requirements
Cost	• Potential use of external expertise	• No charge
The required time	• Depends mostly on the scope of the analysis	• A couple of hours
Relevance for Moroccan companies	• Suitable for large and medium-sized Moroccan companies with extensive supply chains	• Suitable for Moroccan small and medium-sized enterprises in view of the prerequisites, required time, and the possibility of conducting the evaluation in-house • Preferably used in a workshop with the participation of managers and other relevant company representatives

Note: (Amado et al. 2012) (Environment Agency 2012)

4.3. Use a diverse range of decision support methods

To develop customized adaptation strategies, decision support tools can be particularly useful for SMEs, often with limited resources. Participatory approaches align these tools with the specific context and needs of these companies (Fünfgeld, Lonsdale, and Bosomworth 2019). Supporting this decision-making process involves mobilizing a range of methods such as multi-criteria decision analysis, cost-benefit analysis, cost-effectiveness analysis, and expert opinion (Lim and Spanger-Siegfried 2004). It would also be useful to recall that CC decision-making processes contain informal or individual bias that falls within the modes and levels of governance inherent in these processes (Koerth, Vafeidis, and Hinkel 2017; New et al 2022). (French and Argyris 2018) emphasize the need to develop other means that meet the needs of the different parties involved in the decision-making process and the importance of recognizing the informality of drawing information from it without introducing bias.

The identified constraints are related to the requirements of conducting such an analysis in terms of the basic data used to calculate the economic parameters. The selection of appropriate adaptation techniques and technologies is also

considered a critical aspect that sometimes requires proven expertise in the field (Jaouhari, Stour, and Agoumi 2021b). The following table provides an overview of the methods, techniques, and theories that could be mobilized as the optimized tool is rolled out.

Furthermore, CE evaluations conducted with Moroccan firms show that multi-criteria analysis and cost-benefit analysis can be complex and time-consuming (Jaouhari, Stour, and Agoumi 2021b). Multicriteria analysis requires the optimization of the number of criteria to be kept in the evaluation grid. In this regard, it would be appropriate to use a categorization by order of importance of the selection criteria according to the three groups of criteria: "feasibility," "positive side effects," and "negative side effects" (Jaouhari, Stour, and Agoumi 2021b). For CBA, the identified constraints are related to the requirements of conducting such an analysis in terms of the basic data used to calculate the economic parameters. The selection of appropriate adaptation techniques and technologies is also considered a critical aspect that sometimes requires proven expertise in the field. The following table 3 provides an overview of the methods, techniques, and theories that could be mobilized as the stages and sub-stages of the optimized tool are deployed:

Table 3 Methods, techniques and theories to be used in relation to the steps and sub-steps of the optimized tool.

Steps	Sub-steps	Methods, techniques and theories	References
Preliminary step	Preparation	Stakeholder Mapping	(Walker, Bourne, and Shelley 2008)
Company context analysis	Business/ company context analysis	Documentary analysis	(Bowen 2009)
		Project and investment appraisal	(Götze, Northcott, and Schuster 2008)
		Analysis of resources and skills	(Hall 2009)
	Climate profile	Documentary analysis	(Bowen 2009)
		Historical records analysis	(UKCIP 2009)
		Country risk assessment	
Resilience planning	Risks and opportunity assessments	Environmental and social impact assessment	(Dendena and Corsi 2015)
		Impact chains	(GIZ and EURAC 2017b)
		Supply risk assessment	(Zsidisin et al. 2004)
		Risk mapping	(Scandizzo 2005)
		Risk matrix	(Li et al. 2013)
		Feasibility studies	(Williams et al. 2021)
	Actions prioritization	Multi-criteria analysis (MCA)	(Dodgson et al. 2009)
		Cost-benefit analysis (CBA)	(Cullen 1994)
		Cost-effectiveness analysis (CEA)	(Watkiss 2013)
		Expert judgment	(Thompson, Frigg, and Helgeson 2016)
		Change theory	(Bours, McGinn, and Pringle 2014)
Resilience building	Resilience building	Change theory	(Bours, McGinn, and Pringle 2014)

4.4. Areas of impact and considered risks

Due to the complex nature and scope of modern supply chains, companies can be directly or indirectly affected by weather events. These events fall into two categories: rapid-onset and slow-onset. In Morocco, assessments show that the agri-food sector has multiple direct impacts on the quality and size of agricultural products, practicability of production sites, and routing of these products (Jaouhari, Stour, and Agoumi 2021b).

According to a survey conducted by the General Confederation of Moroccan Enterprises (CGEM), companies operating in the agriculture, tourism, and fisheries sectors are more vulnerable and concerned about the risk analysis of their entire value chain (CGEM 2019). In terms of risk perception, agribusiness companies consider the most affected impact areas (significant to medium risk) as follows respectively: "logistics and stock," followed by "Employees and community," then "market" and "process" (GIZ 2016).

In addition, there are other indirect impacts that require preparation on the part of companies, and whose impacts may not be physical (Wedawatta, Ingirige, and Amaratunga 2010). This preparation is often difficult because of the lack of traceability and documentation of climate-related impacts within the Moroccan companies.

In terms of categorization, there are several approaches to classify the risks affecting the impact areas within the company. The value chain approach (M. E. Porter 1985) divides these areas into two main categories: supporting activities (finance, policy environment, and stakeholder expectations) and key activities, comprising core activities within the firm and those beyond its boundaries (Amado et al. 2012).

Following this logic, Risk Disk (Figure 5) illustrates these risks using overlapping rings, with core operations at the center, followed by value chain risks, and risks arising from broader changes in the economy and infrastructure outside

(Wedawatta, Ingirige, and Amaratunga 2010). This representation is relevant for analyzing the effects of CC by starting with direct impacts on key operations within the firm and extending the analysis by the size of the firm and its industry, that is, the extent of its value chain and stakeholder network.

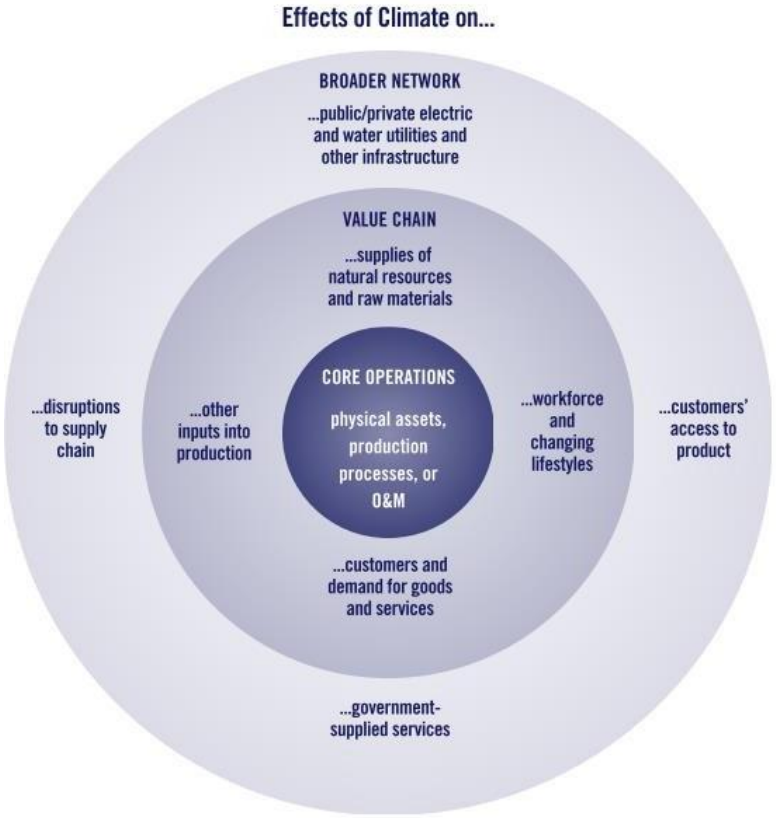

Figure 5 Risk disk (Sussman and Freed 2008).

4.5. Urgent adaptation measures

In the business world, it is imperative to factor uncertainty in all long-term decisions to maintain CC impacts at a tolerable level (Hallegatte 2009). In contrast to a wait-and-see strategy, anticipatory climate risk analysis provides business leaders with the opportunity to plan, finance, and implement risk management measures, often at lower costs. In addition, realizing higher returns and reputational benefits in terms of long-term business resilience and profitability (M. E. Porter et al. 2007). Taking into account the intervention horizon and uncertainty of CC, (Watkiss 2016) identified three broad adaptation intervention groups:

1. Action to address immediate and short-term risks (current and extreme climate variability)
2. Action to improve immediate decisions that have lasting implications (e.g., infrastructure and planning)
3. Action to begin planning for long-term future risks considering future uncertainty.

At the operational level, the company's response strategy must take these three intervention horizons into account and include them in its action plan while ensuring that urgent actions are highlighted. The actions selected by the examined Moroccan companies can be divided into three main categories in order of priority (Jaouhari, Stour, and Agoumi 2021b):

- Category A: Measures should be implemented with high priority
- Category B: Measures should be implemented once high-priority measures are implemented or planned for.
- Category C: Low-priority measures, only implemented if considered useful and feasible after the measures of higher priority have been implemented.

Category A measures are generally considered urgent and must be included in a special resilience plan.

4.6. Integrated business resilience strategy

In their analysis of the options and approaches adopted by firms, (Okereke, Wittneben, and Bowen 2012b) highlighted an integrated typology of climate strategies based on two distinct dimensions. The first dimension focuses on biophysical or political-economic processes, while the second-dimension attempts to address the challenges arising from CC-related causes or consequences.

Companies are expected to play a leading role in limiting global warming while adapting to future climate conditions. The accounting and implementation of GHG emission reduction options generally dominate the discussion around a company's response to the CC (Pinkse and Kolk 2009). Previous literature tends to focus on mitigation measures and has not given sufficient attention to business adaptation strategies (Okereke, Wittneben, and Bowen 2012a). (Haigh and Griffiths 2012) demonstrated that climate-related surprise events have led companies to adapt their operations and strategies to the consequences of CC. This allowed these companies to better understand the link between changes in local climate conditions and the overall CC issue. In view of the regulatory framework, business managers can choose between improving their business through innovation or on compensatory approaches such as the purchase of emission credits (Pinkse and Kolk 2009). In their analysis of business options and approaches, (Okereke, Wittneben, and Bowen 2012b) highlighted an integrated typology of climate strategies based on two distinct dimensions. The first dimension focuses on biophysical or political-economic processes, while the second-dimension attempts to address the challenges arising from the causes or consequences of CC.

In terms of mitigation, there are several guides and approaches dedicated to GHG emissions inventory, reporting and mitigation action plan implementation at the company level (ADEME 2016; WRI 2014). These accounting approaches are generally built around the following steps:

1. Review of organizational and operational context and boundaries;
2. Data collection and quantification of GHG emissions;
3. Development of an action plan to reduce GHG emissions;
4. Monitoring and reporting progress.

Considering this methodological deployment, a certain point of convergence emerges between the mitigation and adaptation approaches at the corporate level. Despite the relatively distinct objectives and evaluation horizons, the integration of these two approaches can be achieved, in particular through: the implementation of a common governance framework, the harmonization of data collection methods, the prioritization of hybrid actions, and the implementation of a balanced reporting including both aspects of the fight against global warming. This highlights the importance of having or hiring new skills within the company with the necessary capabilities in GHG emissions accounting and CC risk and opportunity assessment (Furrer, Hamprecht, and Hoffmann 2012).

4.7. Adaptation monitoring, evaluation & learning

In the context of adaptation, monitoring and evaluation refer to the systematic process of collecting, analyzing, and using information to assess the progress of adaptation and its impacts, particularly in terms of risk reduction outcomes (IPCC 2022b).

The Paris Agreement emphasized the importance of monitoring, evaluating, and learning adaptation plans, policies, programs, and actions (UN 2015) (Article 7.9d). It goes without saying that the inclusion of the monitoring and evaluation component in the optimized version of the CE is crucial. This will help ensure continuous monitoring of adaptation implementation within the company, allow for learning in action, and facilitate decision making under uncertainty (New et al. 2022). In addition to the crucial role of this process in terms of accountability and insight, there is an ongoing implementation of future adaptation actions. Practically, there are several ways to measure the progress of adaptation within a company. The company can use a monitoring and evaluation system based on indicators and indices as well as other tools to acquire the required information, such as surveys, dashboards, interviews, and focus groups (Brooks et al. 2014; J. J. Porter, Demeritt, and Dessai 2015). However, unlike mitigation, there are no universal standard indicators dedicated to measuring adaptation in a comprehensive manner that would be applicable across all businesses (Pringle and Leiter 2018). However, several constraints persist in assessing adaptation within a company, most notably the inability of easily quantifiable indicators to reflect actual changes in their entirety, including results and impacts (Frey et al. 2015).

4.8. Optimized tools for strengthening the climate resilience of Moroccan companies

The development of the optimized tool, which is the subject of this research, is guided by the desire to propose a standardized, simple, and integrated tool for use by Moroccan companies. Based on the structure of the CE tool, terminology and conceptual and contextual modifications were considered in the optimized version. The deployment of the tool was divided into three successive steps, which were preceded by a preliminary preparation stage (Table 4). Accordingly, we designed a flowchart defining the synoptic diagram of the deployment of the optimized tool and the sequencing of its different stages and substages (Figure 6).

The proposed flowchart -in its current format- is a methodological framing tool for assessing climate-related risks and opportunities for companies wishing to adopt a CC resilience and adaptation approach, and for implementing customized climate-resilient strategies. In the future, we aim to transform the proposed tool into a comprehensive web application that is interconnected with existing climate and geographic databases, allowing for the automatic processing of inputs for multi-criteria analysis and cost-benefit analysis. In order to achieve an integrated climate strategy at the company level, the updated version of this tool will also harmonize the adaptation and GHG emissions accounting approaches.

Table 4 Steps and sub-steps of the optimized version of the tool.

Steps	Sub-steps
Preliminary step	• Scope and reference year of the analysis • Organization and governance aspects of the process
Company context analysis	• Business/ company context analysis • Climate profile
Resilience planning	• Risk assessment and vulnerability • Mitigation and adaptation goals • Actions prioritization • Integration of mitigation actions • Urgent Business Resilience Plan
Resilience building	• Financing and implementation of resilience actions • Awareness and communication • Monitoring and evaluation

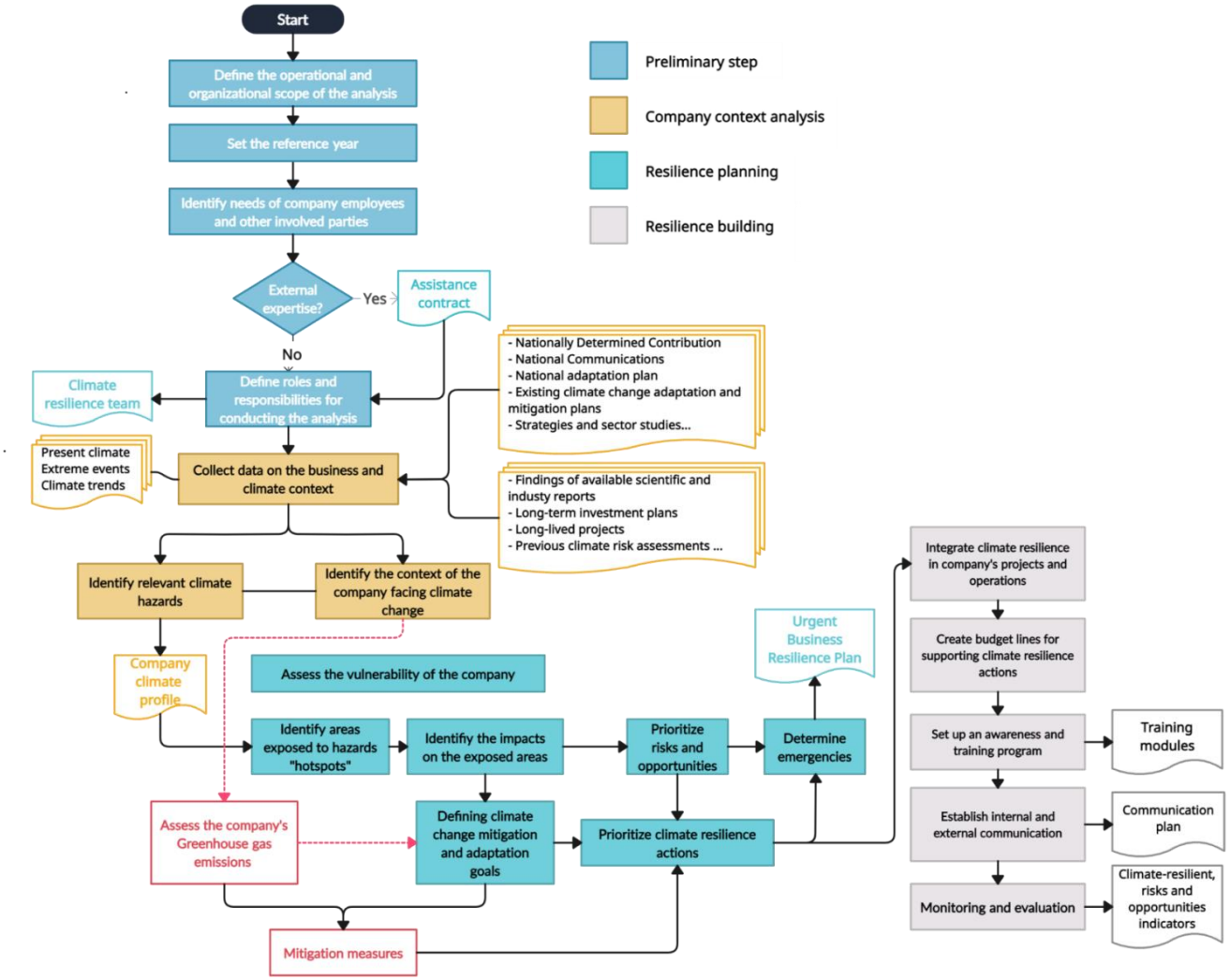

Figure 6 Optimized tool deployment synoptic diagram.

5. Conclusions

Globally, CC-resilient development remains urgent (IPCC 2022d). It requires strong political commitment, enabling institutional frameworks and matching tools to plan and implement actions to build resilience and ensure low-carbon development. CC imposes a range of risks on businesses, materialized in particular by increasing physical risks, accompanied by the risks of disrupting the business model to mitigate GHG emissions and adapt to the impacts generated by CC (Sanderson et al. 2017). It is vital for businesses to maintain these impacts and risks in all long-term decisions at a tolerable level (Hallegatte 2009; Matthews and Mendoza 2015).

Moroccan SMEs, the backbone of the national economy, are weakened by a series of climate constraints that affect their competitiveness (MTEDD 2021b). With the actual and potential impacts of CC, the viability of these SMEs is threatened

more than ever because of their exposure to climate hazards. To respond to these hazards, SMEs' technical and financial capacities often remain insufficient, making them highly vulnerable to CC impacts (Schaer 2018).

Placing these companies on a resilient and low-carbon (RBC) pathway means accompanying them to develop integrated and personalized strategies that combine adaptation to climate change with GHG emission mitigation.

This research has focused on proposing an optimized tool to help Moroccan companies assess their risks and vulnerability to CC and implement targeted strategies to effectively address climate-related challenges across the company's value chain. This tool is deployed through a participatory approach that considers the company's means and resources as well as its specific context and needs. This approach begins with an analysis of risks in the areas of impact: first related to core operations, followed by value chain risks, and then risks arising from broader changes in the economy and infrastructure. For the sake of integration, the tool also identifies relevant points of articulation with the GHG accounting approach, including governance, data collection, prioritization of hybrid actions, and reporting. The proposed response strategy distinguishes between three intervention horizons, emphasizing the development of an urgent action plan that brings together all prioritized adaptation measures.

Ethical considerations

Not applicable.

Conflict of Interest

The authors declare that they have no conflict of interest.

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