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# Bouncing Back from Extreme Weather Events: Some Preliminary Findings on Resilience Barriers Facing Small and Medium-Sized Enterprises

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## ABSTRACT

Extreme weather events (EWEs) pose unprecedented threats to modern societies and represent a much-debated issue strongly interlinked with current development policies. Small and medium-sized enterprises (SMEs), which constitute a driving force of economic growth, employment and total value added, remain highly vulnerable to and ill prepared for such environmental perturbations. This study investigates barriers to SMEs' resilience to EWEs in an attempt to shed light on enabling factors that can define effective organizational responses to non-linear environmental stimuli. Relying on structural equation modeling and data gathered from 109 SMEs that recently experienced EWE impacts, we link the general concept of SMEs' resilience barriers to EWEs with a series of elements to determine specific internal and external factors that contribute the most to EWE resilience. In particular, external barriers of institutional conditions and mechanisms of support and guidance as well as internal barriers of resources and managerial perceptions are found to be the most critical ones in determining resilience. The assessment offers essential research evidence for practitioners on SME management and sets forth linkages with current mechanisms for policy interventions towards an appropriate resilience agenda for SMEs. Copyright © 2018 John Wiley & Sons, Ltd and ERP Environment

**Keywords:** extreme weather events; resilience; small and medium-sized enterprises; climate change; environmental perturbations; sustainable development

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## Introduction

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SCIENTIFIC EVIDENCE SUGGESTS THAT CLIMATE CHANGE (CC) IS EXPECTED TO FURTHER AFFECT THE CARRYING CAPACITY OF ECOSYSTEMS, generate large-scale environmental changes and increase the occurrence of extreme weather events – EWEs (IPCC, 2013; Munich Re, 2013; Stern, 2007). Owing to a massive scale as well as scope, irreversibility, destructiveness and high uncertainty, such impacts can be highly discontinuous (Gasbarro and Pinkse, 2016). In Europe, recent years have witnessed severe heat waves, major floods, heavy precipitation and extreme storms (see, e.g., Dlugolecki, 2009; Poumadère *et al.* 2005) while the frequency and intensity of such impacts are projected to escalate (Forzieri *et al.* 2016).

Unexpected changes and disruptive events have always been a major challenge for business planning (Halkos and Skouloudis, 2016; Weick and Sutcliffe, 2001). However, very few environmental problems exhibit as much strategic challenge (and uncertainty) as that associated with CC and EWEs (Amran *et al.* 2016; Barnett, 2001; Evangelinos *et al.* 2015; Gasbarro *et al.* 2016; Gunawansa and Kua, 2014; Whiteman *et al.* 2011). Such environmental perturbations incur abrupt changes to business organizations in terms of asset damage, operational interruptions and increased costs as well as declining revenue and growth (Linnenluecke *et al.* 2012; Linnenluecke *et al.* 2011; Winn *et al.* 2011). It is therefore critical for businesses to identify such risks (Weinhofer and Busch, 2013), to reduce their vulnerability to EWE threats and, ultimately, to effectively build their resilience to climate-induced physical challenges (see, e.g., Tsalis and Nikolaou, 2017). Resilience indicates the ability to withstand, to adapt and to quickly recover from stresses and shocks (European Commission, 2012). In this respect, organizational resilience signifies a blend of cognitive, behavioral and contextual properties that allow a business entity to effectively absorb, develop situation-specific responses and ultimately engage in transformative activities to capitalize on disruptive surprises that potentially threaten its very survival (Lengnick-Hall *et al.* 2011). Fostering the resilience capacity of a firm enables it to overcome survival threats and actually secure its longevity and prosperity in a complicated, uncertain and volatile environment (Korhonen and Seager, 2008; Seville *et al.* 2008; Sutcliffe and Vogus, 2003).

In its attempt to move towards higher levels of resilience to EWEs, an enterprise may face an array of barriers. As such inhibitory factors are reduced, the firm will gain new skills, exploit new capabilities and achieve interventions or improvements towards better business continuity planning (Okereke, *et al.* 2012). Likewise, when business entities experience extensive barriers to building resilience, any intentions to foster disaster risk management will rarely be translated into actions. Such obstacles to managing environmental challenges can be either internal or external (Chan, 2008; Hillary, 2004; Shi, *et al.* 2008). Barriers not pertaining within the firm (i.e. external barriers) refer to parameters that are out of the direct control or influence of the organization. Internal barriers are on the other hand dependent upon parameters that may be directly controlled by the business entity, indicating intrinsic characteristics – attributes, resources and/or capabilities.

In this context, the present study focuses on Greece, presents preliminary findings of a quantitative assessment of barriers to SMEs' resilience to EWEs and contributes to an emerging body of literature aiming to respond to questions such as the following: (i) How can SMEs be better prepared and more resilient to addressing challenges of CC?, and (ii) how can SMEs overcome barriers and enhance enabling conditions for increased resilience to EWEs? Responding to such pressing issues offers a discerning approach for addressing key aspects of sustainable development, since equipping these companies to confront the climatic turbulence and extreme weather improves the development options of future generations (Denton *et al.* 2014; Moore and Manning, 2009; Sheffi, 2007). The study's originality stems from its contribution to the emerging field of climate services and the considerably under-researched topic of SMEs' resilience to CC and environmental perturbations (Jones & Phillips, 2016). Empirical evidence on the business responses towards CC impacts primarily focus on efforts to manage the carbon footprint of business entities (Okereke, 2007), while empirical findings on business CC adaptation are still thin on the ground, pertaining mostly to responsible *corporate* adaptation (see, e.g., Frey *et al.* 2015). With this in mind, the present study is the first in its field to provide a realistic examination of barriers SMEs facing in coping with EWEs.

The next section encapsulates the study's motivation and outlines prior literature on SMEs and resilience to EWEs. The subsequent two sections present the material and methods of the study and the main findings, respectively. A discussion of the results, along with implications for researchers, practitioners and policy-makers, are presented in the final section.

### Background and Motivation for the Study

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SMEs account for 99% of all European enterprises; they contribute more than 50% of the total value added created by the EU business sector and drive employment by providing more than 60% of the private sector jobs (European Commission, 2015a). In the case of Greece, 86.5% of total private sector employment is concentrated in these enterprises and accounts for 72.8% of gross value added. Balios, *et al.* (2016) point out the country's critical characteristics that make it a unique opportunity for research on small business resilience. It is a developed economy and member of a community of developed countries in terms of macroeconomic and institutional structures. According to Eurostat, SMEs represent the absolute majority of domestic business activity (99.9%), with high employment growth (4.3%) compared with the EU28 average (1.5%), and thus retain a vital role in national growth in comparison with other EU28 countries. Additionally, Greece has been hit most severely by the recent economic crisis, with more than seven years having passed since the national economic downturn erupted. Indeed, 2015 data reveal that, while value added growth at the Member State level was generally positive (EU28: 5.7%), Greece experienced a 1% decline (Muller *et al.* 2016), underpinning the domestic business sector as a unique case for investigating organizational resilience in the European Research Area.

SMEs are more vulnerable and ill-prepared to face extreme weather conditions compared to their larger counterparts, so they are disproportionately affected by EWEs (Crichton, 2009). This is due to limited resources, and a tendency towards short-term planning, reacting to circumstances as they arise and focusing on survival (Smith and Smith, 2007). Likewise, they share less formalized structures and codified policies, while they are most usually owner-managed resulting in a command-and-control management culture (Ates *et al.* 2013). These characteristics result in SMEs having limited opportunities to recover from adverse weather extremes or quickly turn their operation around from a loss-making to a profit-making one (Ingirige and Wedawatta, 2011).

EWEs can disrupt the efficiency of supply chain networks where many SMEs are embedded, and incur infrastructure and facility damages as well as inventory cost and downtime losses (Snyder and Shen, 2006). Considering that they play a major role in business-to-business markets and a large number of SMEs are embedded in large-scale production chains, increasing their resilience capacity to EWEs is a matter that warrants considerable attention. Moreover, these enterprises are also strongly embedded in their local communities (Spence, 2007). Therefore, they can play a pivotal role in mobilizing society to adopt anticipatory adjustments to the physical impacts of CC (Linnenluecke *et al.* 2013) and act as a useful stakeholder in relief and disaster recovery (Johnson *et al.* 2011). Hence, SMEs can contribute to the swift and successful recovery of local communities in which they are established (McManus *et al.* 2008), while the collective loss of a considerable number of SMEs due to weather extremes may devastate a local economy (Yoshida and Deyle, 2005).

Taking into account that EWE-related economic damage has reached record levels over the past decade (Munich Re, 2013), addressing the barriers that SMEs face in building their resilience capacity becomes a sheer necessity. Nevertheless, current literature on business responses to CC stimuli (e.g. Linnenluecke and Griffiths, 2010) is mostly fueled by normative arguments on how organizational resilience can be developed, while empirical findings on measurement and appraisal of organizational resilience to CC are thin on the ground (Gasbarro and Pinkse, 2016). Indeed, despite the facts that small and medium business entities potentially face greater losses from the effects of CC and EWEs (Runyan, 2006) and that their role within supply chains and local sustainability is vital (Hong and Jeong, 2006), the organizational literature seldom concentrates on SMEs' resilience potential to such risks, with the exception of very few studies (Darnhofer, 2010; Galbreath, 2014; Kuruppu *et al.* 2013; Wedawatta and Ingirige, 2012; Wedawatta *et al.* 2010; Williams and Schaefer, 2013).

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### Material and Methods

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Our assessment seeks to identify associations between the various observed items forming the individual internal and external latent constructs as well as the associations of these constructs with the more general concepts of internal and external barriers in a holistic manner. To achieve this, we utilize recently collected data (from an

ongoing research project) gathered through structured questionnaires administered to owner-managers of SMEs located in the Attica prefecture, Greece ( $n = 109$ ). The survey is conducted in municipalities of the greater urban area of Attica recently experiencing EWEs (i.e. heavy precipitation/storms, flash flooding or temperature extremes) and follows a two-stage sampling approach. In the first stage 15 urban area blocks are selected based on the severity of EWE impacts on local business activities, while in the second stage a snowball technique is followed to select those SMEs most affected by EWEs in previous years. Among the 109 participating SMEs, 77 (71%) belong to retail/service sectors, while 32 (29%) are enterprises with manufacturing/secondary sector activities. Table 1 presents sample size figures according to the number of employees per enterprise.

The data collection instrument relies on 25 items measuring the level of agreement over a series of internal and external barriers (observed items) to resilience to EWEs, measured on a 1–5 Likert scale. A full description of the observed variables used as an initial input for constructing the latent factors described above can be found in the appendix.

To test the proposed methodological framework (Figure 1) we have followed a statistical modeling approach. Specifically, we have fitted a structural equation model (SEM) (Bollen, 1989) in order to test the hypothesized conceptual model. The hypothesized modeling scheme is a two-level conceptual model. We first explore the direct connections between the observed items forming the individual internal/external barriers and the corresponding constructs, whereas in the second layer of the model we add a testing of the two-layer SEM model, by allowing for the individual latent factors of internal and external barriers to directly affect the two general latter structures of internal and external barriers.

The selection of SEM modeling for the current analysis was deemed as a suitable statistical methodological approach (in comparison with more conventional approaches such as regression analysis) for various reasons. First, SEM differs from a typical regression-based model, since with SEM the dependent and independent variables can be either observed or latent, a feature that cannot be addressed by typical regression analyses. Hence, SEM possesses a distinctive characteristic of latent variables being regressed on other latent variables, such as those analyzed in the current study. Second, SEM allows fitting model structures of different layers. The researcher can add connections not only between dependent (i.e. concepts of internal/external barriers) and explanatory variables but also between the explanatory ones (i.e. observed individual items and sub-constructs), so that indirect associations between the independent variables can be identified, a feature that could not be implemented by typical regression techniques.

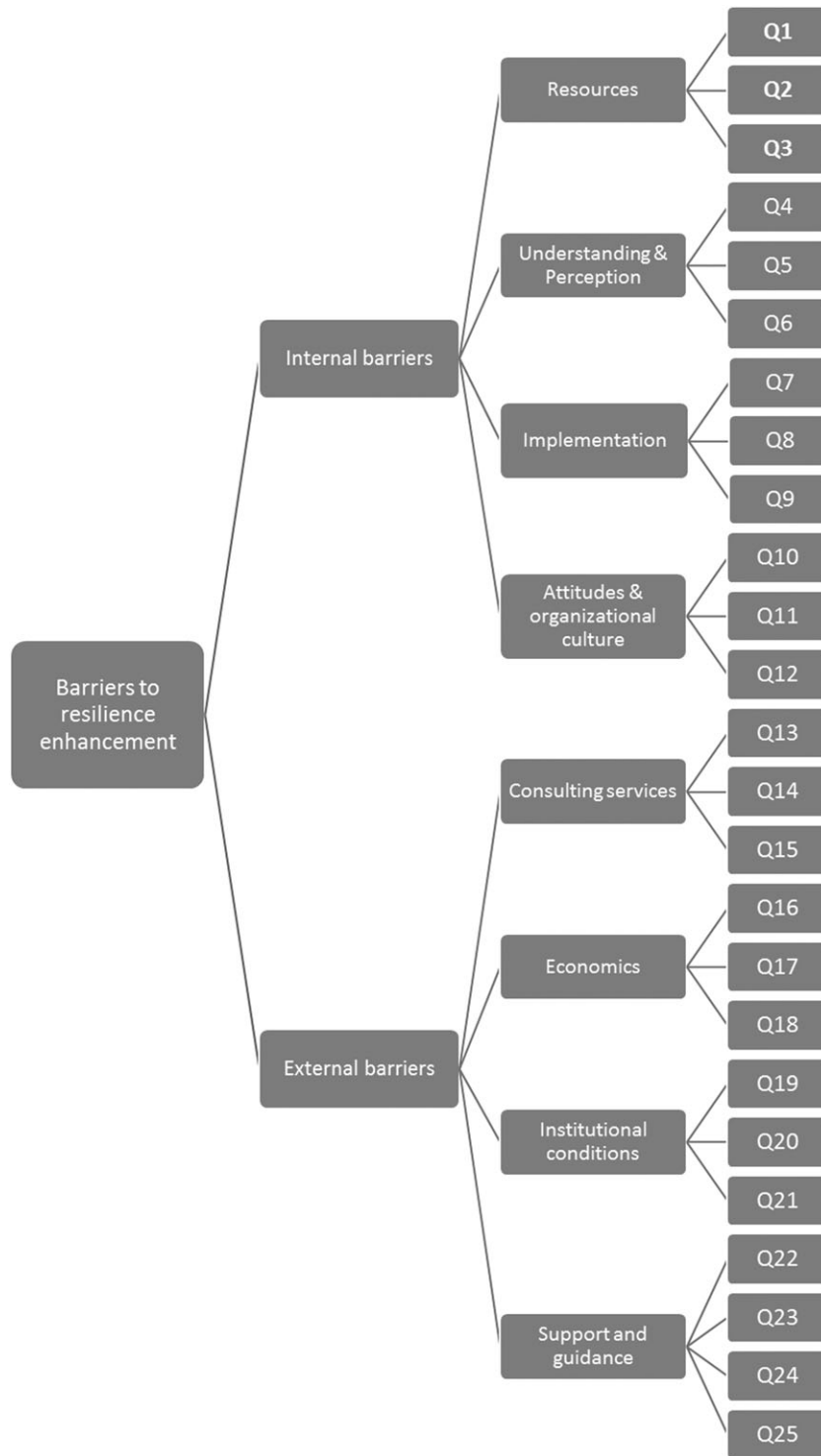
In order to test the influence of the 25 items on the latent constructs that contribute to the SMEs' barriers, we performed the SEM model analysis using the AMOS software (Arbuckle, 2006) which allowed us to draw indicative findings from the sample of 109 SMEs. The sample size meets the absolute minimum requirement of 50 respondents for the SEM modeling to provide valid inferences (Hair *et al.* 2006), although the recommended size is 100 or above.

### Items Utilized for the SEM Modeling

An analytical description of the observed items from the questionnaire that were utilized for the construction of the individual latent factors of internal/external barriers is provided in the Appendix. In particular, a total of 25 observed variables were selected – measured in an ordinal Likert scale – which were included in four factors to form the more general factors of internal and external barriers, respectively. Analytically, the eight individual factors utilized for the

Enterprise category (staff headcount)	Number of enterprises (%)
Medium sized (<250)	15 (14%)
Small (<50)	50 (46%)
Micro (<10)	44 (40%)

**Table 1.** Sample size per enterprise category.



**Figure 1.** The proposed methodological framework.

current analysis are described below, along with Cronbach's  $\alpha$  values (Bollen, 1989) and the percentage of variance of the selected items explained by each of the latent factors:

### Internal Barriers

1. Three-item scale factor (Cronbach's  $\alpha$ : 0.809; % of explained variance: 72.4) measuring barriers referring to the availability of *resources*.
2. Three-item scale factor (Cronbach's  $\alpha$ : 0.458; % of explained variance: 49.63) measuring *understanding and perception* barriers.
3. Three-item scale factor (Cronbach's  $\alpha$ : 0.66; % of explained variance: 72.18) measuring barriers to the *implementation* of resilience measures.
4. Three-item scale factor (Cronbach's  $\alpha$ : 0.097; % of explained variance: 36.01) measuring barriers pertaining to *attitudes and organizational culture*.

### External Barriers

1. Three-item scale factor (Cronbach's  $\alpha$ : 0.351; % of explained variance: 43.6) measuring barriers to seeking *business continuity/adaptation consulting services*.
2. Three-item scale factor (Cronbach's  $\alpha$ : 0.157; % of explained variance: 39.22) measuring barriers of (*macro-*) *economic/market* nature.
3. Three-item scale factor (Cronbach's  $\alpha$ : 0.553; % of explained variance: 53.17) measuring barriers referring to *institutional conditions*.
4. Four-item scale factor (Cronbach's  $\alpha$ : 0.385; % of explained variance: 64.64) measuring barriers relating to *support and guidance*.

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## Results

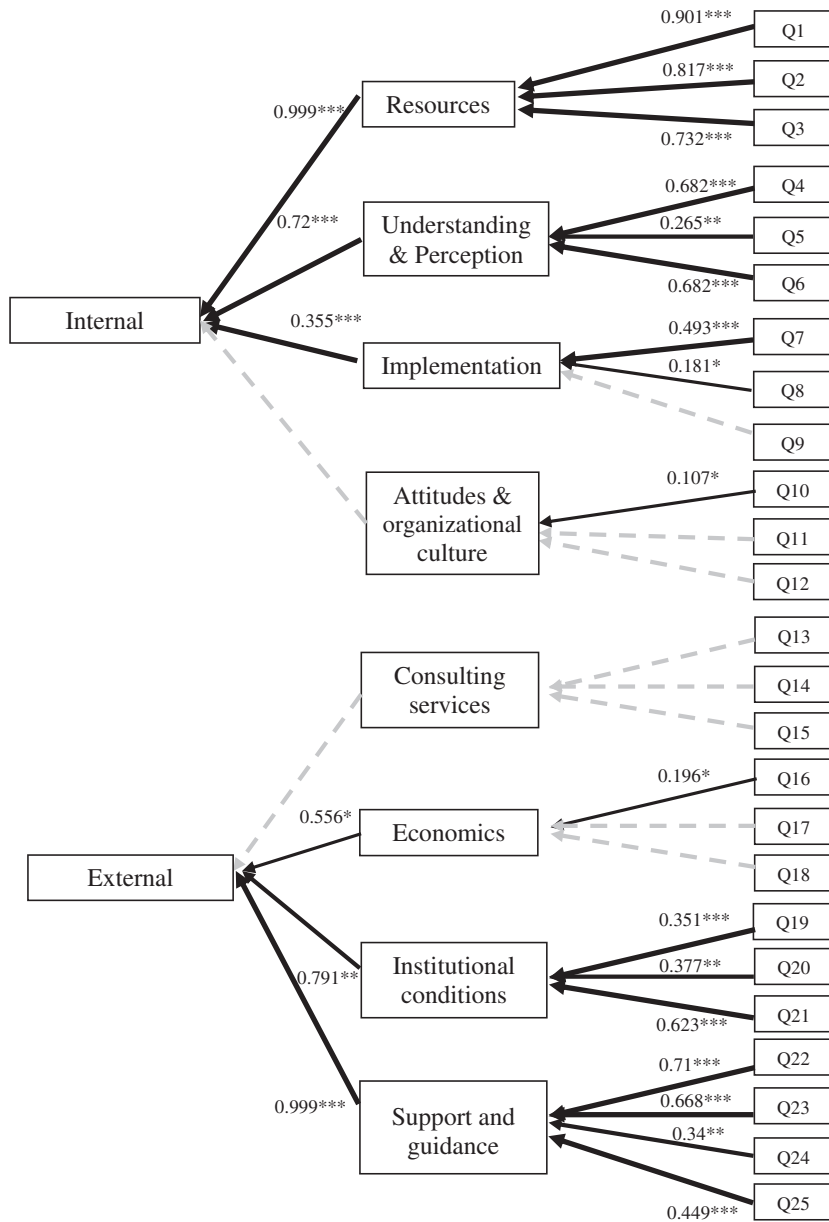
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The path diagram obtained by the fit of the SEM model is presented in Figure 2, summarizing the most important findings. The single-headed arrows in the path diagram are used to denote the direction of assumed causal influence, while the numerical values next to each arrow indicate the (standardized) regression weights ( $\beta$ ) of the corresponding item on the latent variables as well as the weights from the four internal/external groups of barriers to the overall factors of external and internal barriers. The statistical significance of each association is indicated in the graph with the use of asterisks. The loadings of non-statistically significant paths are not reported for space saving; however, the corresponding arrow of causality is marked with a dashed line in the case of the associations found to be non-significant.

The results of the analysis revealed that the specific model conceptualization provides a moderate to good fit to the data. Fit statistics for the SEM model reveal that the path analysis structure tested provided a moderate to good fit, since that most of the values are at the borderlines of acceptable limits.

Most of the observed items of internal barriers to SMEs' resilience to EWEs (questionnaire items Q1 to Q12) have a significant effect on the assigned corresponding factor, with the exception of the 'attitudes and organizational culture' internal barrier. The most dominant factors are found to be those of 'resources' (regression weight  $\beta=0.999$ ;  $p < 0.001$ ) and 'understanding and perception' barriers ( $\beta=0.72$ ;  $p < 0.001$ ). A marginal significance is also observed for the 'implementation' barrier factor ( $\beta 0.355$ ;  $p < 0.001$ ).

As regards to the external barriers, the most important barrier factors are those of resilience barriers referring to 'institutional conditions' ( $\beta=0.791$ ;  $p < 0.001$ ) and 'support and guidance' ( $\beta=0.999$ ;  $p < 0.001$ ). The 'economic' barriers contribute marginally to the external barrier construct ( $\beta=0.556$ ;  $p < 0.1$ ). It is only the effects of the factor pertaining to the provision of business continuity/adaptation consulting services that is found to be non-significant for the external barriers.



—▶ Significant direct positive effect

- - - -▶ Insignificant direct effect

\* $p < 0.1$ ; \*\* $p < 0.05$ ; \*\*\* $p < 0.001$ ; chi-square 310.958 ( $p$ -value 0.05); GFI 0.77; AGFI 0.728.

**Figure 2.** Estimated SEM model for the internal/external barrier constructs.

The importance of how the various observed variables contribute to the individual latent constructs of external and internal barriers was also respectively examined. As regards the ‘resources’ barrier construct, it is observed that all three variables (i.e. [Q1], [Q2] and [Q3]) are of importance for its construction. This indicates that resilience due to the internal factor of resources is almost equally attributed to the lack of time to design, implement and monitor

resilience measures, the lack of relevant training and expertise of staff members, along with financial constraints. This is also supported for the latent construct of the ‘understanding and perceptions’ barrier, since all three tested items load strongly on the specific factor, with most dominant effects attributed to the perceived absence of clear benefits for the firm ( $\beta=0.682$ ;  $p < 0.001$ ) to viewing EWE resilience measures as additional, potentially bureaucratic, operational procedures ( $\beta=0.682$ ;  $p < 0.001$ ). In contrast, the ‘implementation’ barrier construct is primarily affected by the observed variable [Q7], reflecting a perceived interruption of more important operational processes within the firm ( $\beta=0.493$ ;  $p < 0.001$ ), whereas it is marginally affected by variable [Q8], i.e. doubts on the actual effectiveness of resilience actions ( $\beta=0.181$ ;  $p < 0.1$ ).

As regards to the items that comprise the important latent constructs of external barriers referring to ‘institutional conditions’ and ‘support and guidance’, it is observed that all individual observed items load strongly on the latter constructs. In particular, as regards to the ‘institutional conditions’ barrier we find that the complexities of the regulatory framework [Q21] are an important factor for this barrier type ( $\beta=0.623$ ;  $p < 0.001$ ). Likewise, the lack of related promotion activities [Q19] and inadequate information provision by authorities on the design and implementation of such resilience measures [Q20] are found to have a strong positive effect on the ‘institutional conditions’ barrier. The ‘support and guidance’ barrier is mostly affected by the (perceived) low quality and inconsistency ( $\beta=0.71$ ;  $p < 0.001$ ) as well as the lack of SME-specific knowledge ( $\beta=0.668$ ;  $p < 0.001$ ) characterizing external support mechanisms (i.e. [Q19] and [Q20]). Inadequate support of trade associations and business chambers ( $\beta=0.34$ ;  $p < 0.05$ ) along with absence of clear guidance from stakeholders ( $\beta=0.449$ ;  $p < 0.001$ ) are also found to be critical aspects of EWE resilience barriers. The economic-related barrier, which contributes marginally to the overall latent construct of external barriers, is mainly affected by the volatile macroeconomic environment variable [Q16] ( $\beta=0.196$ ;  $p < 0.1$ ).

Our SEM modeling tests failed to obtain a stable model convergence by retaining the associations between the two general latent constructs of internal/external barriers and the fourth-layer factor of barriers to SME resilience (as hypothesized in Figure 1). While this is a task of ongoing research, this finding is indicative of the diversity between the internal and external barriers towards the complex goal of building resilience and their differences with respect to the SME owner-managers’ viewpoints and their related responses.

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## Concluding Remarks

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EWEs pose threats of massive discontinuous changes, and reliance on existing organizational routines and business-as-usual approaches are deemed to be insufficient and bound to lead to suboptimal responses (Linnenluecke *et al.* 2012; Linnenluecke and Griffiths, 2010; Winn *et al.* 2011). A key issue in decision-making towards fostering business resilience to EWEs is to identify barriers that undermine the ability of firms to respond in a timely and effective manner to such environmental stimuli and disruptive events. The way SMEs respond to EWEs has yet to be thoroughly investigated in the literature (Linnenluecke *et al.* 2012; Winn and Pogutz, 2013). Thus, the study’s results present a first indication that certain elements of external and internal barriers have a significant positive effect on SMEs’ resilience to EWEs, while other hypothesized associations were not found to be important. Reliance on a single set of inhibitory factors may not allow the enhancement of organizational resilience if other clusters of barriers that can offset desirable outcomes are overlooked. Therefore, all barrier groups should be identified and considered by devising relevant schemes and incentives under the scope of a ‘climate-proof’ SME sector. Internal barriers pertaining to resources as well as managerial perceptions can be critical, as suggested by the statistical analysis of gathered data. In relation to the external barriers, those referring to institutional conditions and to mechanisms of external support and guidance are equally critical in defining resilience responses. However, the main outcome of the analysis is that the hypothesized model of SMEs’ barriers can be a valid instrument for linking the various individual latent constructs of resilience barriers with the more generic concepts of internal and external inhibitory factors. In this respect, our study reveals that a better understanding of multiple parameters hindering SME resilience to EWEs could yield a more refined explanation of how these enterprises interpret and handle such physical impacts. In line with prior evidence, the study indicates that resource



## **SMEs barriers to EWEs resilience**

constraints and managerial perceptions seem to be key parameters for the level of engagement in resilience measures (Galbreath, 2014; Williams and Schaefer, 2013). Likewise, external factors pertaining to institutional conditions—arrangements and stakeholder support have been also pointed out in previous resilience studies (Darnhofer, 2010; Kuruppu *et al.* 2013).

Assessing barriers to resilience is indeed a promising avenue of fruitful evidence for policy interventions aimed at stimulating SMEs to upgrade their ability to withstand EWE phenomena. Findings from resilience studies such as ours can be useful in putting forth a tentative framework on determinants of SME response to climate risks, informing strategic SME management as well as regional or sectorial policy design so as to steer these enterprises towards sustainability. The latter could be achieved by primarily focusing on industries facing high climate risks or particularly vulnerable to EWEs. Through the provision of ad hoc policy tools such as tax reliefs and subsidies, reward schemes, awareness-raising or capacity-building initiatives, the resilience capacity of these CC-sensitive SMEs could be strengthened and barriers reduced. Further, government support to market mechanisms in terms of fee-based and customized climate services for the production and communication of best available CC knowledge to small business entities could also be a strong determinant of effectively coping with climate-induced physical changes (European Commission, 2015b). Similar to market-based CC mitigative actions (e.g. emission trading schemes), policy-making on reducing the time-to-market of respective resilience innovations would promote a long-term adaptation trajectory for such enterprises.

Internal training and development programs could be a first step in assisting staff members to gain better apprehension of what EWE resilience encapsulates and how it can be nurtured. In order to encourage SMEs at early stages of the resilience learning curve, policies that stimulate multi-stakeholder partnerships for local resilience strategies as well as information- or expertise-sharing could play a critical role. This is because local stakeholders can potentially contribute to outreach activities for information-sharing, and the promotion of up-to-date resilience measures within the local community (including the local business sector). Therefore, in reducing SMEs' barriers to EWE resilience capacity, governmental bodies should work on cultivating local governance and utilize the dynamics of local jurisdiction in tackling the CC challenges (Gunawansa and Kua, 2014). By providing resilience-specific market intelligence, addressing knowledge gaps and disseminating best-practice guides, governmental bodies may assist in fostering an enabling environment for successful SME resilience. Indeed, policy-makers should consider stimulating learning-based and participative stakeholder processes (Kemp *et al.* 2007) backed up with economic incentives to SMEs, since resilience measures may involve considerable investments as well as long-term payback periods (Galbreath, 2014). This could be further supported by initiating regional SME initiatives aiming to attract investment funding opportunities and facilitate inter-firm cooperation or synergies, which could drive resilience-specific innovations and refined SME management capabilities. Strategic directions such as those set forth by the European Commission (European Commission, 2013; European Committee of the Regions, 2017) are an important step forward, as they can navigate enterprises through CC complexities by increasing available resilience options, supporting mechanisms and 'rules of thumb' to counter EWE pressures.

Beside these managerial and policy implications, certain avenues for future research emerge as well. Indeed, our assessment is location specific, and thus evidence cannot be generalized. However, it does indicate a need for more spatial research to account for how and why SMEs under different regional peculiarities face difficulties and fail to cope with such environmental disruptions. In our analysis we focused on SMEs with prior experience of EWE adverse impacts. This could be extended through a comparative lens to a wider range of enterprise profiles (not just those being previously acquainted with an EWE or most vulnerable to such disruptions) in order to shed light on the varying levels of preparedness and the related spectrum of resilience barriers. Likewise, the business activity context (i.e. sector) as well as SME owners' pro-environmental behavior should be of major interest to resilience researchers. Longitudinal and action research studies are necessary to capture how barriers are reduced, resilience capacity is shaped in temporal terms and related strategies are implemented within the enterprise over time. Finally, a fruitful area for future research would be to contrast empirical evidence on SMEs' resilience barriers with findings from inhibitory factors related to CC mitigation measures. Addressing both sides of the same coin may yield actionable insights for the development of composite frameworks on the array of challenges SMEs face in coping with CC and provide the individual enterprise with a holistic perspective of relevant strategic pathways.

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## References

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- Amran A, Ooi SK, Wong CY, Hashim F. 2016. Business strategy for climate change: an ASEAN perspective. *Corporate Social Responsibility and Environmental Management* 23(4): 213–227.
- Arbuckle JL. 2006. Amos 7.0 User's Guide. SPSS: Chicago, IL.
- Ates A, Garengo P, Cocca P, Bititci U. 2013. The development of SME managerial practice for effective performance management. *Journal of Small Business and Enterprise Development* 20(1): 28–54.
- Balios D, Daskalakis N, Eriotis N, Vasiliou D. 2016. SMEs capital structure determinants during severe economic crisis: the case of Greece. *Cogent Economics and Finance* 4(1): 1145535.
- Barnett J. 2001. Adapting to climate change in Pacific Island countries: the problem of uncertainty. *World Development* 29(6): 977–993.
- Bollen KA. 1989. *Structural Equations with Latent Variables*. Wiley-Interscience: New York.
- Chan E. 2008. Barriers to EMS in the hotel industry. *Hospitality Management* 27: 187–196.
- Crichton D. 2009. *The Climate Change Report – Coping with Climate Change: Risks and Opportunities for Insurers*. Chartered Insurance Institute: London.
- Darnhofer I. 2010. Strategies of family farms to strengthen their resilience. *Environmental Policy and Governance* 20(4): 212–222.
- Denton F, Wilbanks TJ, Abeyasinghe AC, Burton I, Gao Q, Lemos MC, Masui T, O'Brien KL, Warner K. 2014. Climate-resilient pathways: adaptation, mitigation, and sustainable development. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects*, Field CB *et al.* (eds), Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge; 1101–1131.
- Dlugolecki A. 2009. *Coping with Climate Change: Risks and Opportunities for Insurers*. Chartered Insurance Institute: London.
- European Commission. 2012. *The EU Approach to Resilience: Learning from Food Security Crises*. European Commission: Brussels.
- European Commission. 2013. *An EU Strategy on Adaptation to Climate Change, COM(2013)216*. Brussels: European Commission.
- European Commission. 2015a. *Annual Report on European SMEs 2014/2015*. Brussels: European Commission.
- European Commission. 2015b. *A European Research and Innovation Roadmap for Climate Services*. Brussels: DG Research and Innovation.
- European Committee of the Regions. 2017. *Opinion of the European Committee of the Regions: Towards a New EU Climate Change Adaptation Strategy – Taking an Integrated Approach*. Publications Office of the European Union: Luxembourg.
- Evangelinos K, Nikolaou I, Leal FW. 2015. The effects of climate change policy on the business community: a corporate environmental accounting perspective. *Corporate Social Responsibility and Environmental Management* 22(5): 257–270.
- Forzieri G *et al.* 2016. Multi-hazard assessment in Europe under climate change. *Climatic Change* <https://doi.org/10.1007/s10584-016-1661-x>
- Frey B *et al.* 2015. *The Business Case for Responsible Corporate Adaptation: Strengthening Private Sector and Community Resilience. A Caring for Climate Report*. UN Global Compact.
- Galbreath J. 2014. Climate change response: evidence from the Margaret River wine region of Australia. *Business Strategy and the Environment* 23(2): 89–104.
- Gasbarro F, Pinkse J. 2016. Corporate adaptation behaviour to deal with climate change: the influence of firm-specific interpretations of physical climate impacts. *Corporate Social Responsibility and Environmental Management* 23(3): 179–192.
- Gasbarro F, Rizzi F, Frey M. 2016. Adaptation measures of energy and utility companies to cope with water scarcity induced by climate change. *Business Strategy and the Environment* 25(1): 54–72.
- Gunawansa A, Kua HW. 2014. A comparison of climate change mitigation and adaptation strategies for the construction industries of three coastal territories. *Sustainable Development* 22(1): 52–62.
- Hair JF, Black WC, Babin BJ, Anderson RE, Tatham LR. 2006. *Multivariate Data Analysis*. Pearson: Upper Saddle River, NJ.
- Halkos G, Skouloudis A. 2016. Exploring the current status and key determinants of corporate disclosure on climate change: evidence from the Greek business sector. *Environmental Science and Policy* 56: 22–31.
- Hillary R. 2004. Environmental management systems and the smaller enterprise. *Journal of Cleaner Production* 12: 561–569.
- Hong P, Jeong J. 2006. Supply chain management practices of SMEs: from a business growth perspective. *Journal of Enterprise Information Management* 19(3): 292–302.
- Ingirige B, Wedawatta G. 2011. SME resilience to extreme weather events: important initiatives for informing policy making in the area. *International Conference in Building Resilience: Annual Conference of the International Institute for Infrastructure Renewal and Reconstruction (IIIRR)*, Kandalama, Sri Lanka.
- Intergovernmental Panel on Climate Change (IPCC). 2013. *Fifth Assessment Report*. Cambridge University Press: Cambridge, New York.
- Johnson BR, Connolly E, Carter TS. 2011. Corporate social responsibility: the role of Fortune 100 companies in domestic and international natural disasters. *Corporate Social Responsibility and Environmental Management* 18(6): 352–369.
- Jones AW, Phillips A. 2016. Voluntary business engagement in climate change: a study of the ClimateWise principles. *Journal of Cleaner Production* 137: 131–143.

## SMEs barriers to EWEs resilience

- Kemp R, Loorbach D, Rotmans J. 2007. Transition management as a model for managing processes of co-evolution towards sustainable development. *International Journal of Sustainable Development and World Ecology* 14: 78–91.
- Korhonen J, Seager TP. 2008. Beyond eco-efficiency: a resilience perspective. *Business Strategy and the Environment* 17(7): 411–419.
- Kuruppu N, Murta J, Mukheibir P, Chong J, Brennan T. 2013. Understanding the Adaptive Capacity of Australian Small-to-Medium Enterprises to Climate Change and Variability. Gold Coast, Australia: National Climate Change Adaptation Research Facility (NCCARF).
- Lengnick-Hall CA, Beck TE, Lengnick-Hall ML. 2011. Developing a capacity for organizational resilience through strategic human resource management. *Human Resource Management Review* 21(3): 243–255.
- Linnenluecke M, Griffiths A. 2010. Beyond adaptation: resilience for business in light of climate change and weather extremes. *Business and Society* 49(3): 477–511.
- Linnenluecke MK, Griffiths A, Winn M. 2012. Extreme weather events and the critical importance of anticipatory adaptation and organizational resilience in responding to impacts. *Business Strategy and the Environment* 21(1): 17–32.
- Linnenluecke MK, Griffiths A, Winn M. 2013. Firm and industry adaptation to climate change: a review of climate adaptation studies in the business and management field. *Wiley Interdisciplinary Reviews: Climate Change* 4(5): 397–416.
- Linnenluecke MK, Stathakis A, Griffiths A. 2011. Firm relocation as adaptive response to climate change and weather extremes. *Global Environmental Change* 21(1): 123–133.
- McManus S, Seville E, Vargo J, Brunsdon D. 2008. Facilitated process for improving organizational resilience. *Natural Hazards Review* 9(2): 81–90.
- Moore SB, Manring SL. 2009. Strategy development in small and medium sized enterprises for sustainability and increased value creation. *Journal of Cleaner Production* 17(2): 276–282.
- Muller P, Devnani S, Julius J, Gagliardi D, Marzoc C. 2016. Annual Report on European SMEs 2015/2016: SME Recovery Continues. European Union, Contract EASME/COSME/2015/012.
- Munich Re. 2013. 2012 Natural Catastrophe Year in Review. Munich: Munich Re.
- Okereke C. 2007. An exploration of motivations, drivers and barriers to carbon management: the UK FTSE 100. *European Management Journal* 25: 475–486.
- Okereke C, Wittneben B, Bowen F. 2012. Climate change: challenging business, transforming politics. *Business and Society* 51(1): 7–30.
- Poumadère M, Mays C, Le Mer S, Blong R. 2005. The 2003 heat wave in France: dangerous climate change here and now. *Risk Analysis* 25(6): 1483–1494.
- Runyan RC. 2006. Small business in the face of crisis: identifying barriers to recovery from a Natural Disaster. *Journal of Contingencies & Crisis Management* 14(1): 12–26.
- Seville E, Brunsdon D, Dantas A, Le Masurier J, Wilkinson S, Vargo J. 2008. Organisational resilience: researching the reality of New Zealand organisations. *Journal of Business Continuity & Emergency Planning* 2(3): 258–266.
- Sheffi Y. 2007. *The Resilient Enterprise: Overcoming Vulnerability for Competitive Advantage*. MIT Press: Cambridge, MA.
- Shi H, Peng SZ, Liu Y, Zhong P. 2008. Barriers to the implementation of cleaner production in Chinese SMEs: government, industry and expert stakeholders' perspectives. *Journal of Cleaner Production* 16: 842–852.
- Smith MH, Smith D. 2007. Implementing strategically aligned performance measurement in small firms. *International Journal of Production Economics* 106(2): 393–408.
- Snyder LV, Shen ZJM. 2006. Supply chain management under the threat of disruptions. *Bridges* 36: 39–45.
- Spence LJ. 2007. CSR and small business in a European policy context: the five 'C's of CSR and small business research agenda. *Business and Society Review* 112(4): 533–552.
- Stern NH. 2007. *The Economics of Climate Change: the Stern Review*. Cambridge University Press: Cambridge.
- Sutcliffe KM, Vogus TJ. 2003. Organizing for resilience. In *Positive Organizational Scholarship: Foundations of a New Discipline*, Cameron KS, Dutton JE, Quinn RE (eds). Berrett-Koehler: San Francisco; 94–110.
- Tsalis TA, Nikolaou IE. 2017. Assessing the effects of climate change regulations on the business community: a system dynamic approach. *Business Strategy and the Environment* <https://doi.org/10.1002/bse.1953>
- Wedawatta G, Ingirige B. 2012. Resilience and adaptation of small and medium-sized enterprises to flood risk. *Disaster Prevention and Management* 21(4): 474–488.
- Wedawatta G, Ingirige B, Amaratunga D. 2010. Building up resilience of construction sector SMEs and their supply chains to extreme weather events. *International Journal of Strategic Property Management* 14(4): 362–375.
- Weick K, Sutcliffe K. 2001. *Managing the Unexpected: Assuring High Performance in an Age of Uncertainty*. Wiley: San Francisco.
- Weinhofer G, Busch T. 2013. Corporate strategies for managing climate risks. *Business Strategy and the Environment* 22(2): 121–144.
- Whiteman G, de Vos DR, Chapin FS, Yli-Pelkonen V, Niemelä J, Forbes BC. 2011. Business strategies and the transition to low-carbon cities. *Business Strategy and the Environment* 20(4): 251–265.
- Williams S, Schaefer A. 2013. Small and medium-sized enterprises and sustainability: managers' values and engagement with environmental and climate change issues. *Business Strategy and the Environment* 22(3): 173–186.
- Winn M, Kirchgeorg M, Griffiths A, Linnenluecke MK, Günther E. 2011. Impacts from climate change on organizations: a conceptual foundation. *Business Strategy and the Environment* 20(3): 157–173.
- Winn MI, Pogutz S. 2013. Business, ecosystems, and biodiversity: new horizons for management research. *Organization and Environment* 26(2): 203–229.
- Yoshida K, Deyle RE. 2005. Determinants of small business hazard mitigation. *Natural Hazards Review* 6(1): 1–12.

## Appendix. The Data Collection Instrument

Please indicate your level of agreement with the following statements:

	A critical inhibitory factor in building the resilience of my enterprise towards extreme weather events is:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Q1	Lack of time to design, implement and monitor such resilience measures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q2	Lack of relevant training and expertise of members of the staff	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q3	Financial constraints	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q4	Absence of clear benefits for the firm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q5	The relevant management cost is high	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q6	It incurs additional, bureaucratic, internal procedures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q7	It may interrupt other (important) operational processes within the firm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q8	Doubts about the effectiveness of such actions and their objectives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q9	Difficulties in evaluating comprehensively related environmental risks	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q10	Previous experience with non-financial management systems proved they are inefficient within my enterprise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q11	They may bring forward drastic and unwanted changes to my enterprise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q12	I have more critically important issues to engage with	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q13	The costs of consulting in business continuity planning is high	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q14	Business continuity consultants serve their intrinsic interests, which exceed their role in improving business operation and performance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q15	Business continuity consultants will offer low quality as well as largely prescriptive and/or bureaucratic services to the firm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q16	The volatile economic environment influences the importance attached to resilience measures against EWEs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q17	There are no economic incentives to motivate engagement in resilience measures	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q18	The implementation of resilience measures to EWEs has no value in the market place in which my enterprise operates	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q19	Lack of related promotion activities by apposite governmental bodies	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q20	Inadequate information provision by the authorities on the design and implementation of resilience measures to EWEs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q21	The regulatory framework is complex and strict and undermines any attempts to endorse resilience-related modifications within the enterprise	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

(continues)

## SMEs barriers to EWEs resilience

### Appendix (continued)

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Please indicate your level of agreement with the following statements:

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	A critical inhibitory factor in building the resilience of my enterprise towards extreme weather events is:	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
Q22	Mechanisms of external support are of low quality and inconsistent	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q23	Mechanisms of external support lack knowledge of the intrinsic characteristics of the sector in which my enterprise operates	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q24	The trade associations/business chambers my enterprise pertains to offer inadequate support to resilience enhancement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Q25	Absence of clear guidance, information provision to increase awareness as well as assistance by other primary stakeholders of the firm on how to enhance resilience to EWEs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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