

# Small and Medium Enterprise-SMEs' Resilience Model based on Maturity Cycle

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**Abstract**— *Currently, companies deal with the consequences of disruptive events derived from climate change, increased number of hurricanes, changes in wildlife species, pandemics and so on. Small and Medium Enterprises (SMEs) are more vulnerable due to their limited financial, human, and operational resources. This requires that companies have greater resilience, incorporating strategies adapted for the development of a maturity to face this situation. This article proposes a qualification model to assess the maturity status of SMEs based on their resilience level. To test the model, fieldwork has been carried out, interviewing three Mexican SMEs, which managed the effects of sargassum in Puerto Morelos. The exposure to large amounts of sargassum in decomposition can affect people with symptoms such as nausea, tearing and headaches, including allergic skin reactions, among other diseases. The use of the instrument allowed identifying the maturity status of the companies linking with the main practices used to increase resilience capabilities. According to the findings, SMEs have no preparation plans to cope a disruption, until when they learn about the impact, because of the crisis. It was clear, with 2 SMEs that the years' experience with other natural disruptions helps them to find new market opportunities to transform their business and help each other as a community.*

**Keywords**—SMEs, Small and medium-sized enterprises, Resilience, Maturity Cycle, Sargassum.

## I. INTRODUCTION

The current environment presents a common characteristic at a global level: uncertainty. Uncertainty in political, economic, social, cultural, and even environmental, with continuous advances in science and technology, but with ever-deeper needs. This uncertainty generates crises and opportunities for companies, but for an SME can mean its disappearance [1], [2], [3]. It is considered that one of the main advantages of an SME is to be flexible due to its size, which can allow quick changes and adjustments according to what arises in the environment. Despite this, innovation and productivity are opportunities for improvement for this type of companies.

The research objective is to develop an instrument that allows to identify the elements that help an SME to survive a time of crisis, according to its stage of maturity level and observe whether there is a relationship with its level of resilience. The research methodology identified literature linked to SMEs, resilience, and the level of maturity in this type of companies. Once the literature review was done, an instrument was developed considering the elements of resilience, the level of maturity of these companies and their ability to act. The research concludes with a pilot application in three SMEs of a tourist community in Puerto Morelos, Mexico: (1) a hotel, (2) a restaurant and (3) a tour business. The results

identify preliminary findings and improvements opportunities to the instrument for future applications.

## II. LITERATURE REVIEW

### A. Latin-American SME's

According to the Economic Commission for Latin America and the Caribbean (CEPAL), SMEs in Latin America provide 67% of all workers. Although in some countries their contribution is still low due to their low productivity levels, the level of importance has been growing due to their role in each of the countries of Latin America. The Organization for Economic Co-operation and Development (OECD) [4] has recently defined SMEs as "key actors for promoting more inclusive and sustainable growth, increasing economic resilience and improving social cohesion" (p.3). The importance of SMEs in Latin America is established by the impact on their activity in the life of the countries; however, these are the companies with the least capacity to face a crisis of any kind [5]. The environment in which industry operates in Latin America in general is complex and uncertain in political and economic aspects (as a recurring economic crisis), with an inefficient infrastructure and logistics systems, few professionals in the area of supply chain, and lack of support and strategic vision of the government area [2], [6]. On the other hand, the elements that SMEs have to face uncertainties are not many, instead, they present the following weaknesses that have been detected in common among different countries [3], [4], [7], [8], [9]:

- *A backlog in connectivity and information technology. The trend in Digital Business Platforms is present at any industry and is changing current business models as well as work systems.*
- *Low levels of staff education and training. The need to survive, causes SMEs to decide not to invest in training with the fear of losing staff in a short time.*
- *Low added value in productive systems.*
- *Low levels of innovation in process, products, and services.*
- *High levels of informal processes.*

This context that surrounds SMEs and these deficiencies are the ones that cause life expectancy to be low, a lot of these companies will not survive in the first two years after their creation. Hence the interest in studying the companies that do manage to survive in this environment of uncertainty and determine the elements that allowed them to react and maintain

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themselves, through a model that considers resilience and the cycle of maturity.

### B. *SME's Resilience*

SMEs are vulnerable organizations to crisis, [10] states that after two years of operation, 50% in particularly new ventures, close. A survey carried out by [11] concerning eleven SMEs, determined that 46.3% of the tasks that can limit their growth are associated with the challenges of supply chain management. This means controlling their inventories, managing suppliers and sales and conducting market research. Additional negative effects are in the intersection between logistics and supply chain management and disasters (manmade or with natural origin), as sourcing cut off, transport interruption, poor performance or raw materials scarcity. Supply chain risks are presented and classified by [12]: (a) internal risks to the firm (related to processes and controls), (b) external to the firm but internal to the supply chain network (related to demand and supply management), and (c) external to the network (environmental issues). Likewise, [13] proposes an analysis of supply chain vulnerabilities based on their drivers: (a) supply side (i.e. supplier network), (b) demand side (i.e. customer dependence), and (c) supply chain structure (i.e. global trade coordination). Moreover, [14] presents an extensive review about different quantitative models for managing supply chain risks, such as supplier order allocation under uncertain demands. Also, analyses by [15] review the impact and severity of those called disruptors.

Resilience is the system's capacity to manage disruptive events such as disasters. Authors [16] and [17] present an extent literature review, about its meaning, use, application, components, drivers, and retarders for the development of resilient organizations. Meanwhile, [18] have focus on the nature of resilience, the elements that compose, and their relations on supply chain, main characteristics are: (1) adaptive systemic capacity, (2) continuous processes to manage risks, (3) capacity of response and recovery from disturbances and (4) ability to return to a better state post disruption. In summary, supply chain resilience is defined as an adaptive capacity of an organization and its supply chain to overcome its exposure to a disruptive event (resist), achieving a superior performance state after the crisis (persist).

According with [19], SMEs have characteristics, which indicate that usual analysis on its supply chain must be different from those ones used by large companies, for instance: scarce human and financial resources [20]. In the case of SMEs in the agro-industrial sector, there are also barriers to financing and investment as high initial cost for market access and competition [21]. SMEs use different 'strategies' to deal with its vulnerable state, strategy understood as a "system of management that will facilitate the capability of the organization to respond to an environment that is essentially unknowable, unpredictable and, therefore, not amenable to a planning approach" [22]. Knowing SMEs usually centralize their decision-making in the owner's authority [23]. Empirical

observations suggest owners constitute networks to manage uncertainty business conditions [24]. In addition, the performance such decisions explicitly define the well-being of their organization [25]. It is interesting because [26] explain there is two different ways of conducting decision-making. Some decisions are fast, automatic, effortless, associative, implicit, emotionally charged, governed by habits and difficult to control; these are called "system 1". Other decisions are the product of a slower, deliberative, and more logical thinking process, named "system 2". Apparently, SME's manager seeks to make his organization more resilient using "system 2" that means using his benefit-cost analysis. A case about this kind of strategies, the collaboration, is presented by [27]; the collaboration among SMEs producer was the resilience driver mechanics with develop a flexible and adaptable supply chain that suffered disruptions due to Coastal El Niño 2017.

### C. *SME's maturity Cycle*

In business, the term maturity is related with the capability of an organization to make the things in an outstanding way in a discipline or process. On the other hand, a maturity model is a set of characteristics, attributes, indicators, or patterns that represent progression and achievement in a domain or discipline [28]. So, a maturity model is a tool that allows an organization to know which is its state about its practices, process and/or methods evaluated against the best (or ideal they could be) practices, process and/or methods. The final idea of a maturity model is to give to the organization a road map in the disciplines or processes evaluated to improve and thus achieve the highest levels according to its current status.

Maturity models have some particular purposes [29]: (1) Descriptive: The maturity model is used as a diagnostic tool, placing the company in one of the levels predefined in the model, (2) Prescriptive: The maturity model must identify desirable maturity levels and give a road map to improve and (3) Comparative: The maturity model must allow make benchmarks or comparisons in order to establish the actual level of the company in the discipline or processes against others. Maturity models have been proposed and developed for multiple disciplines (Information Technology, Software Development, Grid Operations, and so on) since the Capability Maturity Model (CMM) was developed by the Software Engineering Institute [30]. In resilience domain including risk and disaster management (discipline close linked with resilience) exist some proposals to assess the maturity. CERT-RMM v1.1 is a capability- focused maturity model for process improvement that reflects best practices of security management, business management and IT operations management. This maturity model is focused on high-value services to meet their mission consistently and with high quality [31], [32]. On the other hand, [33] propose a maturity model to evaluate the cities' resilience, involving the different stakeholders of a city in the city resilience building process. Some propose a basic framework to construct a maturity model to assess the supply chain resilience, although in very general

way [31]. According to the literature review, all the above models and other initiatives have been directed toward large or medium companies, and there is not relevant evidence about models focused on the evaluation of the maturity level of resilience in micro and small-sized companies located in contexts similar to Latin America, which is one of the contributions of this paper. To develop a maturity model in resilience, is necessary to define the types of disruption, which can be classified as caused by nature (as earthquakes, floods, hurricanes, and so on) or by humans. Now, those caused by humans, can be divided in intentional disruptions (for example strikes) or by negligence (as fire or financial crisis). This classification is a combination of proposals made for some authors [12], [35], [36]. Now, for each type of disruption, is necessary to evaluate three dimensions [35]: (1) Detectability: It is the ability to detect the disruption before it occurs. (2) Likelihood: It is the probability that the disruption will occur and (3) Impact: It measures the potential consequences if the disruption occurs. Each kind of disruption will be analyzed following the three dimensions explained to score the criticality of the disruption. Table 1 shows an example of the possible evaluation of three disruptions. The score given to the criticality of the disruption can correspond to an empirical approach given from the knowledge on the organization and the cause of the disruption.

TABLE I  
EVALUATING THE GRADE OF CRITICALITY OF THE DISRUPTION

Cause of the Disruption	Appearance			Criticality of the disruption
	Likelihood	Detectability	Impact	
Flood	High	Medium	High	Very High
Fire	Low	High	Medium	Medium
Port Closure	Very Low	High	Low	Low

In order to facilitate the design of an instrument to determine the SME maturity level to cope with different types of disruptions, we adapted the eight stages to deal disruptive events proposed by [35] in: 1) preparation, 2) disruptive event, 3) first response, 4) initial impact, 5) time of full impact, 6) preparation for recovery, 7) recovery and 8) long-term impact.

According with the results about the criticality of the possible disruptions, the resilience maturity model assesses the stages and activities according with levels proposal by [34], which is shown in Table 2.

TABLE II  
RESILIENCE MATURITY MODEL STRUCTURE

Stage	Activity Ability to:	Maturity Level				
		Ad Hoc	Defined	Linked	Integrated	Extended
Preparation	Identify the disruption					
	Evaluate the disruption					
	Monitor the disruption					
	Detect early alerts					
	Generate Plans					

Stage	Activity Ability to:	Maturity Level				
		Ad Hoc	Defined	Linked	Integrated	Extended
Response	Implement Plans					
	Control the situation					
	Safe and protect human lives					
	Turn off the affected systems					
Recovery	Retrieval and time to do it					
Evolution	Identify opportunities					
	Transform and evolve					

### III. METHODS AND PROCEDURES

#### A. Methodology

The methodology has 3 main steps (see Fig.1): (1) definition of the theoretical framework about SMEs, Resilience and Maturity Cycle; (2) Resilience Maturity Model Structure construction; and (3) Pilot case using the model proposal and feedback. In the first phase, the context is defined for the analysis of SMEs that affects their performance and survival. The concept of resilience is defined, and how it can be observed in this type of companies; and the literature linked to the maturity cycle and the stages that make it up are analyzed. In the second phase, the findings in the literature are analyzed and the structure of the maturity cycle of a company is defined with the actions linked to a resilient organization. With them, a collection instrument is designed based on an in-depth interview for SMEs facing a crisis.

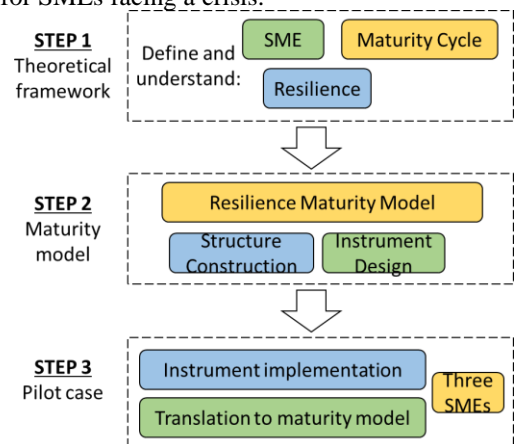


Fig. 1 Sargassum at Puerto Morelos (Sep. 2018) and Puerto Morelos Beach without Sargassum (Oct. 2019)

In the third phase, an interview is applied to SMEs of a community facing an environmental crisis with direct impact on their businesses, which cannot be predicted, it simply happens, and sometimes with greater dimensions than expected. Once the instrument is applied, the qualitative results are translated into the model to determine the results it gives us, and to carry out the pertinent adjustments.

### B. Puerto Morelos Pilot Case

Puerto Morelos is a small city in the Mexican Caribbean, with more than 10,000 inhabitants, located between the main tourist centers of Cancun and Playa del Carmen. Its main economic activity is linked to the tourism sector, mainly foreign (Canada, United States and Europe), in a proportion 80-20 with national tourism. Puerto Morelos has 16 small and medium hotels and more than 80 restaurants. At 500 meters from its beach is the second largest reef in the world after Australia, considered a national park. Since 2011, the beaches of the Mexican Caribbean have been affected by an unusual natural phenomenon; high amounts of sargassum have appeared on the Atlantic Ocean, affecting the habitat for 120 species of fish and almost the same number of invertebrates. The studies indicate that this new influx of sargassum come from the coast of Brazil. Sargassum arrives frequently decomposed to Mexican beaches and accumulated generates an unpleasant smell of rotten egg, this is due to the hydrogen sulfide gas in natural state of decomposition. Exposure to large amounts of sargassum in decomposition, affects a person with symptoms such as nausea, tearing and headaches, including allergic skin reactions [37], [38].

During the summer of 2018, the arrival of more than 20 million tons was estimated, distributed in the Riviera Maya. The beach of Puerto Morelos was seen affecting between 5 and 7 meters from the shore to the sea, and the natural blue view turned brown (see Fig.2). The impact of the sargassum phenomenon in the Riviera Maya has relation to the reduction of international and national tourists (occupancy levels of 75% compared to 90% in the same season 2 years earlier). Another negative effect is the impact on the reef, with 40% damage, killing the reef and related fauna. Sargassum phenomenon is an environmental crisis facing the communities of the Riviera Maya and Puerto Morelos, this was one of the reasons for applying the pilot test of the instrument. A second reason is the link that exists with the community of Puerto Morelos and TEC university, for two years, 40 students and teachers develop sustainability and social projects with the community.



Fig. 2 Sargassum at Puerto Morelos (Sep. 2018) and Puerto Morelos Beach without Sargassum (Oct. 2019)

The Resilience Maturity Model was adapted in a semi-structured interview that allowed to know the level of maturity in each of the stages of resilience. These questions enable the identification of the actions of the small companies interviewed in each phase of the resilience process when facing a crisis, considering also the level of maturity of the company itself. The first section of questions considers the general data of the company such as number of employees, staff profile, products or services offered, time on the market, target market, etc. In the second section, questions were developed related to the identification of the crisis in this case environmental, and its impact on the company with indicators of % of decrease of clients, sales, performance in relation to employee's vs incomes and others. The last section addresses the actions and decisions they took to counteract the situation, including new products or services, cost reduction, or even new investments, or other actions such as those aimed at repeat customers (loyal customers), etc.

The instrument was applied to 3 SMEs linked to tourism. Using interview process, with files recorded and photos, findings gives feedback to strengthen the instrument:

- (1) a hotel, founded in 1985, currently has 2 buildings, 28 rooms, and 12 employees,
- (2) a restaurant, founded 21 years ago, 10 employees including the owner, five in the morning shift and five in the afternoon shift. Offers service from 7 am to 11pm and
- (3) a promoter of tourist activities (tours), founded three years ago, with five employees including two owners.

### C. Qualitative results

The instrument has 3 sections: (a) the general data section of the SME as years in the market, personnel that make it up, facilities that include, to name a few; (b) the resilience section that considers elements such as human resource management, economic-financial management, and operations and strategy management, and the last section, (c) the maturity status.

The grade of the criticality of the disruptions in case of Puerto Morelos due to the Sargassum is classed as an environmental crisis by the last 2 years, with the high likelihood of realization next years, high impact, and medium detectability (see Table 1). In relation to the result of the interviews of the 3 SME cases, considering the Resilience Maturity Model Structure proposed the following findings were found (see Table 3):

In the Preparation phase, three cases present similar situations, the community (not only businesses) had warning of a different behavior from the Sargassum, without determining estimated date, and without the level of impact so they did not define preventive plans. However, they were monitoring the natural disruption, and this monitoring has become more specialized to date, for instance using traffic lights to prevent impact by zones in the riviera. In the Response phase, the hotel and restaurant generated plans to take advantage of opportunities generated, as it is mentioned by the interviewers, as the next comment shows:

"we were looking for ways to cope with what was coming up, for example: we tried to promote the destination more not as a beach destination only but as an adventure destination".

Another action was to increase the use of advertising places to promote local events: Cirque du Soleil performance, concerts and sports tournaments (Polo), or offer another kind of options as they shared: "we also offer medical tourism packages to foreigners as cosmetic surgeries and dentists' treatment. "

Instead, in the case of the promoter of tourist activities, it didn't developed clear plans related its activity. This small company had to reduce their staff from 5 people to 2 (the owners only).

In the Recovery and Evolution phase the 3 SMEs define actions to retrieval and time to do it:

- *The hotel SME did facilities inversion during 2018 (when the occupation rates drop 35 %), even now they didn't recover the inversion but starts to have 90% occupation.*
- *The restaurant has many projects opportunities to offer their services to new companies and families.*
- *The tours promoter starts to recover with more costumers and again with 3 more personnel staff. Only this SME did not clarify how they transform its services.*

TABLE III  
RESILIENCE MATURITY MODEL TO PUERTO MORELOS CASE

Stage	Activity Ability to:	SME cases		
		Case A	Case B	Case C
Preparation	Identify the disruption	X	X	X
	Evaluate the disruption	-	-	-
	Monitor the disruption	X	X	X
	Detect early alerts	-	-	-
	Generate Plans	-	-	-
Response	Implement Plans	X	X	X
	Control the situation	X	X	
	Safe and protect lives	NA <sup>a</sup>	NA	NA
	Turn off the affected systems	NA	NA	NA
Recovery	Retrieval time used	X	X	X
Evolution	Identify opportunities	X	X	X
	Transform and evolve	X	X	-

<sup>a</sup>NA: Not Applicable

The description shown above allows establishing the degree of maturity for each company: to hotel and restaurant SMEs was classes as "linked" and tour services as "defined".

TABLE IV  
RESILIENCE MATURITY LEVEL

Resilience Maturity Level	Case A	Case B	Case C
	Linked	Linked	Defined

## RESULTS AND DISCUSSION

SMEs play an important role in the economy of Latin American countries. Moreover, like the rest of industry and society, an environment of uncertainty surrounds them: economic, political, social and environmental. This causes their survival rate in the competitive environment to be low, so it is of special interest to define the resilience of an SME and its relationship with its maturity cycle as a business. The Resilience Maturity Model Structure shows different phases related how each SME responds if a disruption occurs.

Authors like [18] show resilience as an adaptive capacity of an organization and its supply chain to overcome its exposure to a disruptive event. In Puerto Morelos Case, the community starts to work together, defining specifics actions and finding new products and services for tourist sectors, offering hotel, restaurants, and tours promoter all-inclusive services together.

It was interesting to identify that a resilience communitarian was strengthened in Puerto Morelos through "the Puerto Morelos Protocol", a nongovernmental organization, which specific goals are deployed actions to control sargassum using specialized equipment and technology and finding uses and products made by Sargassum.

## CONCLUSIONS AND FUTURE RESEARCH

The proposed model aims to evaluate and measure the maturity level of resilience that more vulnerable enterprises as SMEs must cope disruptions caused by nature or humans. The model was applied to three small firms in Puerto Morelos to assess the capability to cope a natural disruption caused by the Sargassum. According with the findings, when a natural disruption event occurs, SMEs have no preparation plans, until when they have learned about the impact, as consequence of the crisis. It was clear, with two of SMEs that the years' experience with other natural disruptions as hurricanes, helps them to find new market opportunities to transform their businesses, and help each other as community.

This model is still under construction, and the pilot has served to improve it to develop in the future one more robust that could be applied to any type of disruption, mainly focused on Latin American countries. For this, it is important to determine the most common types of disruptions and its levels of criticality, which allows to obtain the real levels of maturity of resilience of SMEs. All this information will permit

determinate actions that must be taken for governments and/or enterprises to improve resilience levels. All the above are part of our future research

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