

What we know and do not know about organizational resilience

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Abstract: We present a literature review about organizational resilience, with the goal of identifying how organizational resilience is conceptualized and assessed. The two research questions that drive the review are: (1) how is organizational resilience conceptualized? and (2) how is organizational resilience assessed? We answer the first question by analyzing organizational resilience definitions and the attributes or characteristics that contribute to develop resilient organizations. We answer the second question by reviewing articles that focus on tools or methods to measure organizational resilience. Although there are three different ways to define organizational resilience, we found common ideas in the definitions. We also found that organizational resilience is considered a property, ability or capability that can be improved over time. However, we did not find consensus about the elements that contribute to improving the level of organizational resilience and how to assess it. Based on the results of the review, we propose a conceptualization of organizational resilience that integrates the three views found in the literature. We also propose a four-level Maturity Model for Organizational Resilience – MMOR. Using this model, the organization can be in one of the following levels based on its ability and capacity to handle disruptive events: fragile, robust, resilient or antifragile.

Key words: Antifragility, Resilience, Robustness, Organizational resilience, Conceptualization, Assessment.

1. Introduction

During the last years, the study of resilience has become more important because people are more aware of the consequences of natural and human-made disasters (Tukamuhabwa, Stevenson, Busby, Zorzini, 2015). Some authors think that the study of resilience is gaining importance due to the speed of changes in the economy, society, and technology (e.g. Horne III, 1997). Due to this speed of changes, survival is now considered a critical aspect of business, and being resilient is important for such survival.

Although there is increasing interest in this research area, there is no agreement about where these ideas were first introduced. Some (Coutu, 2002) say that

it was in Psychology. Others (Henry & Ramirez-Marquez, 2010; Annarelli & Nonino, 2016) say that the concept was popularized after Holling (1973), “Resilience and Stability of Ecological Systems”.

Today, research on resilience is important in many different fields such as Management, Ecology, Psychology, Disaster Management, Organization Management, Sociology, and Engineering. As research in resilience has been attacked in many areas, there is no widely accepted definition, even in the same area (Bergström, van Winsen, Henriqson, 2015).

At first sight, one may think that there is no relation among the different research areas on resilience. For instance, one could believe that resilience against disasters is not related to building resilient systems,

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organizations or individuals. However, several authors have already identified relationships between the different fields. For example, we need resilient individuals to build resilient organizations (Biggs, Hall, Stoeckl, 2012; Doe, 1994; Mallak, 1997). Resilient organizations also need resilient supply chains (Sheffi, 2007) or resilient infrastructure (Bell, 2002; Erol, Mansouri, Sauser, 2009). Resilient organizations contribute to creating resilient communities (Kendra & Wachtendorf, 2003; Lee, Vargo, Seville, 2013) or societies (Beermann, 2011). Resilient organizations also contribute to developing resilient territory (Gilly, Kechidi, Talbot, 2014). Resilience engineering principles contribute to developing resilient organizations (Righi, Saurin, Wachs, 2015).

Figure 1 represents the relationship among these areas centered on their relation to organizational resilience. Organizational Resilience influences the resilience research areas painted in grey color, and it is influenced by research areas depicted in white color. Organizational resilience is influenced by resilient individuals, resilience engineering, infrastructure resilience, cyber resilience, system resilience, supply chain resilience and business resilience. Organizational resilience influences community resilience, societal resilience, economic resilience, city or urban resilience, territory resilience and socio-ecological resilience.



Figure 1. Relations between resilience concepts and organizational resilience.

Here, we focus on resilience at the organizational level. More specifically, our objective is to identify what we know and what we do not know about the conceptualization and assessment of organizational resilience. Two fundamental questions drive the research: (1) how is organizational resilience conceptualized? and (2) how is organizational resilience assessed?

At the organizational level, resilience has simultaneously emerged from different fields such as Enterprise Risk Management, Business Continuity Management, Emergency Management, Crisis Management, Physical Security, and Cyber-Security (Braes & Brooks, 2010, 2011; Gibson & Tarrant, 2010). In these fields, researchers and practitioners have studied how to protect the organizations against disruptive events.

Louisot (2015) considers resilience as a main issue in Risk Management, and Jackson, Firtko, and Edenborough (2007) view resilience as a new way of thinking about risk. As systems and organizations cannot be designed to anticipate all possible risks (Fiksel, 2003), we need resilient organizations to deal with events that will have serious consequences, even when they have low probability of occurrence (Ambulkar, Blackhurst, Grawe, 2015; Dalziell & Mcmanus, 2004). We also need to study when policies, procedures, practices, and tools fail during an emergency response (Kendra & Wachtendorf, 2003).

Although there are several reviews about resilience at the organizational level (Annarelli & Nonino, 2016; Bhamra, Burnard, Dani, 2015; Bhamra, Dani, Burnard, 2011; Linnenluecke, 2017) the research questions we discussed earlier are not yet answered. Bhamra *et al.* (2011) introduced a general review about resilience based on 74 papers published before 2011. They identified five perspectives for resilience studies (ecological, individual, socio-ecological or community, organizational and supply chain). They focused on the conceptualization of resilience based on these perspectives. However, only three of the definitions they presented were in the context of resilience of organizations. Bhamra *et al.* (2015) presented an updated version of (Bhamra *et al.*, 2011) including 100 articles and five definitions valid for organizations. Annarelli & Nonino (2016) investigated the research domains of organizational resilience based on a literature review and co-citation analysis. They aimed to understand the actual state of development of organizational resilience and the future research directions in this area. They also reviewed several definitions of resilience and organizational resilience, and proposed a new one. However, they did not analyze what are the differences in the conceptualization of organizational resilience. Linnenluecke (2017) focused on the evolution of organizational resilience theory. She acknowledged that there is no unified theory and proposed several future research questions such as

“What capacities bring about resilience really?” or “How resilience can/should be operationalized?”

Although these reviews have dealt with many important issues, there are still many open questions regarding the conceptualization and elements that contribute to resilience and how it is assessed. To address these issues, we propose a conceptualization of resilience following Suddaby (2010), which shows how to construct clarity in Theories of Management and Organization. We also introduce a maturity model for organizational resilience. Finally, we present basic dimensions to assess and measure organizational resilience.

The rest of the paper is organized as follows. In section 2, we explain the methodology we followed to select and analyze the papers. In section 3, we review how organizational resilience is conceptualized. In section 4, we review how resilience is assessed at the organizational level. In section 5, we conclude the paper with a discussion about the conceptualization, assessment and future research lines in the study of organizational resilience. We also introduce our conceptualization and Maturity Model for Organization Resilience (MMOR).

2. Research methodology

As discussed in the introduction, we aim to identify what do we know and do not know about the conceptualization and assessment of organizational resilience. To do so, we conducted a comprehensive search in the literature, and we conducted a systematic review of those research papers. We followed the research protocol depicted in Figure 2, based on (Tranfield, Denyer, Smart, 2003).

We first defined the research questions. To do this we conducted a preliminary search for organizational resilience. This search indicated a lack of consensus about how organizational resilience is defined, what are the factors or attributes that contribute to improve the level of organizational resilience and how we can measure it (Bhamra *et al.*, 2011; Braes & Brooks, 2011; Smith & Fischbacher, 2009). Based on this search, we agreed that, in order to understand organizational resilience better, we needed to study what do we know and what do not know about the following questions: (1) How is resilience conceptualized at the organizational level, and, (2) How is resilience assessed in practice at the organizational level.

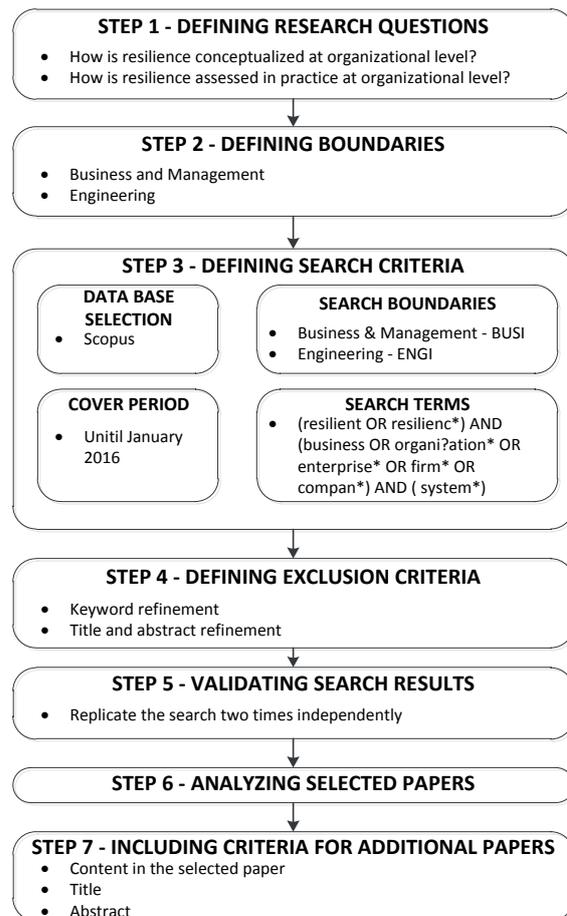


Figure 2. Research protocol.

In a second step, we defined the scope of our research. We are interested in the study of resilience in Management at the organizational level. Therefore, we included the fields of Management and Business. We also included Engineering because our preliminary search indicated that some of the Management results come from Engineering. We discarded Psychology and Human Resources because the study of resilience in these fields is mainly focused on resilience of individuals. We also discarded Finance and Economics because they do not specifically focus on the management of the organization.

In a third step, we defined the search criteria and selected a database to do the search. We considered four databases: IEEE Xplore, ScienceDirect, Scopus and Web of Science. Scopus includes both IEEE and ScienceDirect papers, and Scopus has a larger coverage than Web of Science, though it does not cover some journals (Chadegani *et al.*, 2013). Additionally, it provides more search filters.

Based on the scope defined in step 2, we searched any document indexed in Scopus, written in English, belonging to the subject areas Engineering or Business, Management and Accounting. Before defining the search term criteria, we performed another preliminary scan of the literature related to Organizational Resilience. This showed that some authors also talk about *resilient organizations*, *enterprises* or *firms*. Therefore, we included these keywords in our search. An organization can be defined as “an organized group of people with a particular purpose, such as business or government department” (Oxford University Press, 2017). Therefore, we decided to include *company* and *business*. Additionally, some authors view the organization as a system (Beer, 1989), so we also included the keyword *system*. However, system can also refer to other types of systems, such as control systems, computer network systems or mechanical systems among others. Since the keyword system has several meanings, especially in Engineering, it was only included in Management to avoid results not related to our topic. This search returned 3322 results that cover a time-period from January 1970 until January 2016. This result may contain some duplicates results as the search was carried in a two-step process.

In a fourth step, we defined the exclusion criteria. We refined our results based on the papers keywords and analyzing their title and abstract. We realized that there were papers that did not include a keyword section (e.g. Mallak, 1998b). If we refined the results using the keyword option in Scopus, those papers would be discarded. To address this issue, we allowed the keywords to be either in the title or in the keyword section. The preliminary scan of the literature showed that resilience is related to other concepts such as risk, reliability, disasters, redundancy, vulnerability, uncertainty, recovery, prevention, robustness or adaptation. However, we refined the search only using the keyword “*resilien*” (e.g., all the keywords that contain “resilien”), as we wanted to focus on works talking about definitions, characteristics, and measures of organizational resilience. After the keyword refinement, we obtained 1352 papers. We refined again these 1352 papers using their title and abstract. We excluded all the papers whose title or abstract was not related to organizational resilience and Management. We included all the papers that did not specify the type of system that was studied, and discarded those that focused on specific systems not related to Management or Organizations. When the title and abstract did not help to decide if the paper

should be included or not, we took into consideration the journal or conference title. In other cases, we read the full paper. In the end, 143 papers were selected. We noticed that many papers displayed in our search, despite having the keyword “*resilien*” were not related to the topic. Therefore, we discarded them.

In a fifth step, we replicated the search and the refinement two times to validate our results. We considered that reading the title and abstract once was not enough to obtain reliable results.

Finally, we analyzed all the papers. During this step, we realized that some cited relevant papers did not appear in our search because of the content of the title, abstract and keywords. To address this issue, we reviewed the references of those 143 papers to find relevant literature that our search did not display. We included those papers whose title, abstract or the content referenced in the paper was related to the definitions, characteristics or measurement of organizational resilience. We included 48 additional papers. The final number of papers was 191 (143 papers displayed by the search and 48 additional papers based on the references). This core of papers widely represents the works that address the conceptualization and assessment of organizational resilience.

3. How is resilience conceptualized at the organizational level?

Suddaby (2010) stated that a clear conceptualization of any construct has four elements: (1) a good definition, (2) scope conditions or contextual circumstances, (3) semantic relations with other concepts, and (4) coherence and logical consistency. He defined three properties for good definitions: (1) capture the essential properties or characteristics of the concept, (2) avoid tautology, and (3) be parsimonious (i.e. focus narrowly on the meaning but being relevant).

In order to conceptualize resilience at the organizational level, called *organizational resilience* we reviewed over 50 definitions. Bhamra *et al.* (2015) presented 18, and only 5 within the organizational context. They indicated that, although there seems to be a common core understanding of what organizational resilience is, there are issues to be discussed. We also found a lack of a clear conceptualization of the term organizational resilience.

3.1. A review about how organizational resilience is understood

There are three main streams in the conceptualization of resilience: (1) resilience as a feature of an organization (i.e., something that an organization has), (2) resilience as an outcome of the organization's activities (i.e., something that an organization does); and (3) resilience as a measure of the disturbances that an organization can tolerate.

We found that all of them have the same basic meaning: they have an emphasis either on the organization survival, or in dealing with jolts, risks or changes. However, there is no consensus about the following issues: (1) if the risks are only related to threats or also to opportunities, (2) what survival means, (3) if the risks are already known by the organization or not, and (4) if resilience is always a desirable property. We discuss these points in section 3.1.2.

3.1.1. Organizational resilience conceptualization

Resilience as a feature of an organization

Most authors (including Acquah, Amoako-Gyampah, Jayaram, 2011; Alblas & Jayaram, 2015; Ates & Bititci, 2011; Bauernhansl, Mandel, Diermann, 2012; Bhamidipaty, Lotlikar, Banavar, 2007; Chand & Loosemore, 2016; Danes *et al.*, 2009; Demmer, Vickery, Calantone, 2011; Freeman, Hirschhorn, Triad, 2003; T O Grøtan & Asbjørnslett, 2007; Hamel & Valikangas, 2003; Hollnagel, 2010; Horne III, 1997; Yao Hu, Li, Holloway, 2008; Jaaron & Backhouse, 2014; S. Jackson, 2007; Lengnick-Hall & Beck, 2005; Lengnick-Hall, Beck, Lengnick-Hall, 2011; Mafabi, Munene, Ahiauzu, 2015; Mallak, 1997, 1998a; Milanzi & Weeks, 2014; Sheffi & Rice Jr., 2005; Starr, Newfrock, Delurey, 2003; Tillement, Cholez, Reverdy, 2009; Tse, Couturier, Roux, 2012; Winston, 2014), understand organizational resilience as an ability to deal with internal and external changes, risks or jolts. Others, defines it as a capacity to deal with them (Alexiou, 2014; Dewald & Bowen, 2010; Fiksel, 2006; Gilly *et al.*, 2014; Linnenluecke, Griffiths, Winn, 2012; Manyena, 2006; Ortiz-de-Mandojana & Bansal, 2015; Powley, 2009; Proper & Pienaar, 2011; Stewart & O'Donnell, 2007; Tierney, 2003). Finally, some others define it as a capability to deal with these issues (Annarelli & Nonino, 2016; Bell, 2002; Kamalahmadi & Parast, 2016;

Reinmoeller & Van Baardwijk, 2005; Robb, 2000; Zhang & Van Luttervelt, 2011). Ability, capacity, and capability have different connotations; however, the authors of these papers do not clarify why they choose one term or the other. Likewise, they do not define ability, capability or capacity.

These three words are sometimes used as synonyms to refer to the power to perform an action or a task. Therefore, we will assume that these terms are interchangeable in the definitions. Without specifying why they use ability, capacity or capability, some authors combine these terms with a specific adjective to define resilience. For instance, Manyena (2006) and Hollnagel (2010) consider resilience as something intrinsic to the organization. Powley (2009) defines resilience as a latent capacity. Gilly *et al.* (2014) state that the resilience of an organization is both an active and a reactive capacity. Resilience can be also considered something dynamic (Alexiou, 2014; Kamalahmadi & Parast, 2016) or incremental (Ortiz-de-Mandojana & Bansal, 2015).

A group of authors (Burnard & Bhamra, 2011; Hilton, Wright, Kiparoglou, 2012) considers resilience as an emergent property that the organization exhibits when it encounters setbacks. Other authors consider resilience as a process to recover from a disruption (van Breda, 2016). Horne III & Orr (1998) understand resilience as a quality to respond to significant change. Some authors (Erol *et al.*, 2009; Gunasekaran, Rai, Griffin, 2011; McManus, Seville, Vargo, Brunson, 2008) define organizational resilience as a function of specific capabilities or abilities. For instance, McManus *et al.* (2008) define resilience as a function of three abilities or capabilities: adaptive capacity, situation awareness, and management of keystone vulnerabilities. Erol *et al.* (2009) include enterprise flexibility, adaptability, agility, and efficiency as attributes for enterprise resilience. Gunasekaran *et al.* (2011) include adaptability, responsiveness, sustainability, and competitiveness. The essence of these capabilities is the same: dealing with change, environmental jolts or risks. Defining resilience as a function of characteristics indicates that resilience is a complex concept.

Some authors also use different dimensions of resilience in their definitions. For example, Välikangas & Romme (2012) distinguish two dimensions of resilience: operational and strategic. Operational resilience is understood as a way to bounce back after a crisis. Strategic resilience not only means to bounce back but also to turn threats

into opportunities. Lengnick-Hall & Beck (2005) identify three components of resilience: cognitive, behavioral and contextual. Each component provides the organization with some capabilities. Cognitive resilience enables the organization to noticing, interpreting, analyzing and formulating responses that go beyond survival. The elements that contribute to building cognitive resilience include having a constructive sense-making and a strong ideological identity. Constructive sense is related to seeking information and its interpretation to take actions. Ideological identity refers to having value-driven behavior. Behavioral resilience is the engine that makes the organization works. The elements that contribute to building behavioral resilience are a complex and varied action inventory and the functional habits or routines. Complex and varied action inventory means having a number of alternatives to deal with different scenarios. Functional habits or routines help to open new communication channels or seeking resources automatically. Contextual resilience is the framework where cognitive and behavioral resilience takes places. The characteristics that are used to build contextual resilience are social capital and broad resource network.

Resilience as an outcome of an organization

Several authors define resilience with focus on what a resilient organization does. For instance, resilience is defined as *“the maintenance of positive adjustment under challenging conditions such that the organization emerges from those conditions strengthened and more resourceful”* (Sutcliffe & Vogus, 2003; Vogus & Sutcliffe, 2007). A resilient organization can return to its performance level at any key performance metric (Sheffi, 2007). It is able to achieve its objectives and realized opportunities in the face of predicted or unpredicted disruptive events (Hilton *et al.*, 2012; Whitehorn, 2010; Wright, Kiparoglou, Williams, Hilton, 2012).

Resilience as a measure of the disturbance that an organization can tolerate

Resilience has also been defined as a magnitude. Under this view, resilience is the level of disturbance an organization can tolerate and still survive (Linnenluecke & Griffiths, 2010; Mamouni Linnios, Mazarol, Ghadouani, Schilizzi, 2014)

3.1.2. Open issues in resilience conceptualization

Many authors consider resilience as a property related to events that may have a negative impact on the organizations. For example, resilience can be related to surviving or adapting to: disruptions (Bell, 2002; Horne III & Orr, 1998; Yao Hu *et al.*, 2008; Lengnick-Hall *et al.*, 2011; Sheffi & Rice Jr., 2005), disasters or catastrophic events (Tierney, 2003); (Alblas & Jayaram, 2015); challenging conditions (Sutcliffe & Vogus, 2003; Vogus & Sutcliffe, 2007); disturbances (Hollnagel, 2010; Linnenluecke & Griffiths, 2010; Mamouni Linnios *et al.*, 2014; Tillement *et al.*, 2009); threats (Bhamidipaty *et al.*, 2007; Dewald & Bowen, 2010) or changes (Fiksel, 2006; T O Grøtan & Asbjørnslett, 2007; Mafabi *et al.*, 2015; Milanzi & Weeks, 2014; Stewart & O'Donnell, 2007). However, some authors consider that these changes can also be opportunities (Ates & Bititci, 2011; Bhamidipaty *et al.*, 2007; Dewald & Bowen, 2010), and resilient organizations take advantage of these opportunities.

Regarding the discussion about what is the meaning of “surviving” in the context of resilience, some conceptualizations state that an organization is resilient if it bounces back to a prior point of stability (Freeman *et al.*, 2003; Sheffi, 2007). Others acknowledge that an organization is resilient if it returns to the same point or if it achieves another state of stability (i.e., it changes, while minimizing the effects due to changes and hazards) (Acquaah *et al.*, 2011; Burnard & Bhamra, 2011; Demmer *et al.*, 2011). Some authors consider that a resilient organization can also bounce forward, grow or become stronger (Bell, 2002; Fiksel, 2006; Vogus & Sutcliffe, 2007). Woods (2015) identifies four meanings of resilience that bring four interpretations of “surviving”. These four streams are using resilience as rebound (i.e. returning to previous or normal activities after a disruption), robustness (i.e. absorbing disturbances), graceful extensibility (i.e. how to extend adaptive capacity in the face of disruptions) and sustaining adaptability (i.e. the ability to adapt to future disruptions as the conditions change and evolve). These four meanings can be understood as different forms of survival.

Many authors do not define the type of disruptions that resilient organizations are prepared to deal with. Others state that the disruption or change is turbulent (Ates & Bititci, 2011; Bauernhansl *et al.*, 2012; Burnard & Bhamra, 2011; Fiksel, 2006). Others

consider that resilience refers to both expected and unexpected events (Hilton *et al.*, 2012; Hollnagel, 2010; Wright *et al.*, 2012).

Most of the authors consider resilience as a desirable ability or capability for the organizations. Although this is not specifically stated in the definitions, it can be inferred from their work. However, a few authors consider that resilience is not always desirable, depending on the state of the system or organization (Mamouni Limnios, 2011; Mamouni Limnios *et al.*, 2014). For example, in a Cournot duopoly, after an increase in the production cost for both firms in the same amount, companies are not willing to exhibit resilience (understood as bouncing back to the previous state of cost) (Lambertini & Marattin, 2016). The reason is that the new equilibrium in the market may satisfy both companies and they will not be willing to invest money to return to the previous level of costs.

3.2. Resilience and related concepts: fragile, robust and antifragile

To clarify the divergences we presented in section 3.1.2, we need to analyze the concepts related to resilience. Resilience is related to fragility, robustness, and antifragility. The concept of fragility is related to how a system is broken or damaged in the case of variations (Taleb, 2012; Taleb & Douady, 2013). Robustness is the capacity of a system to absorb disturbances (Woods, 2015). Antifragility is a new concept introduced by Taleb (2012), which is defined as the property of a system that, when facing challenges such as failures or volatility, it improves. He differentiates fragile, robust/resilient and antifragile entities, although he uses indistinctly the words resilient and robust.

Woods (2015) pays attention to the difference between robustness and resilience. Being different, using them indistinctly creates confusion when studying resilience. A robust organization absorbs disturbances, but it does not necessarily recover in case of disruptions. Read (2005) provides an illustrative example comparing trees. In case of wind, both a palm and a sycamore tree moves from their equilibrium position. When both trees are exposed to the same wind intensity, the sycamore tree movements are much smaller than the palm tree. Therefore, it is more robust. However, the palm tree is more resilient as it is able to recover easier from bigger disturbances (i.e., the sycamore tree will probably break).

By focusing on the type of disruption that the resilient organizations are prepared to face, these organizations should be able to survive to both known and unknown disturbances. A robust organization is designed to cope and absorb a set of known disturbances. Therefore, a resilient organization is more prepared to survive than a robust one. Following this view of resilience, we consider it as a desirable property in any organization although in section 3.1.2., we show an example (Cournot duopoly) where an organization is not willing to exhibit resilience.

Being resilient is not only related to bouncing back to the same previous point of stability; being resilient is also achieving another desirable point of stability. If this new point is better than the previous one, and the organization is stronger, we consider that this organization is not only resilient but also *antifragile*. The distinction between *resilient* and *antifragile* organizations clarifies the open question about if resilient organization responds just to threats or also to opportunities. If the organization is able to recover or survive to threats, it is resilient. If this same organization takes advantage of the threats and opportunities to become stronger, it is resilient and antifragile.

3.3. Organizational resilience and its attributes

As discussed in section 3.1, resilience is a complex and dynamic concept. Complex concepts are characterized by different elements or attributes (Suddaby, 2010). To identify these elements, we analyzed over 110 works that address different models and frameworks proposed to build or improve organizational resilience. This review revealed that there is a great variety regarding the factors and mechanisms that contribute to resilience. Sometimes, the authors refer to the same concept with different words. For instance, improvisation (Coutu, 2002; Kendra & Wachtendorf, 2002), creativity and innovation (Dervitsiotis, 2004) are used to refer to bricolage skills; face down reality (Coutu 2002) is used to refer to situation awareness. Despite the different terminology, we also found some common and repeated characteristics or factors that contribute to enhance resilience.

The most cited attributes or elements of a resilient organization include building situation awareness (Afgan, 2010; Braes & Brooks, 2010; Coutu, 2002;

McManus *et al.*, 2008), managing organization's vulnerabilities (Erol, Sauser, Mansouri, 2010; McManus *et al.*, 2008; Whitehorn, 2010), having resources (Aleksic, Stefanović, Arsovski, Tadić, 2013; Ates & Bititci, 2011; Brewton, Danes, Stafford, Haynes, 2010; Crichton, Ramsay, Kelly, 2009; Kendra & Wachtendorf, 2002; Mallak, 1998a; Orchiston, Prayag, Brown, 2016), improvisation capacity (Coutu, 2002; Tor Olav Grøtan, Størseth, Rø, Skjerve, 2008; Kendra & Wachtendorf, 2002; Mallak, 1997; Rerup, 2001; Weick, 1993), ability to anticipate events (Apneseth, Wahl, Hollnagel, 2013; Berman, 2009; Hardy, 2014; Rerup, 2001; Wright *et al.*, 2012), agility (Gibson & Tarrant, 2010; Ismail, Poolton, Sharifi, 2011; Megele, 2014; Starr *et al.*, 2003; Thomas, Byard, Francis, Fisher, White, 2016), learning capacity (Aguirre, Dynes, Kendra, Connell, 2005; Burnard & Bhamra, 2011; Hilton *et al.*, 2012; Robb, 2000; Zhang & Van Luttervelt, 2011), collaboration (Alonso & Bressan, 2015; Boza & Poler, 2013; Proper & Pienaar, 2011; Winston, 2014), resiliency of individuals (Doe, 1994; Mallak, 1997; Riolli & Savicki, 2003), flexibility (Berman, 2009; Kendra & Wachtendorf, 2002; Megele, 2014; Pal, Torstensson, Mattila, 2014; Proper & Pienaar, 2011), robustness (Heinicke, 2014; S. Jackson, 2007; Kendra & Wachtendorf, 2002; Pal *et al.*, 2014; Tierney, 2003; Tompkins, 2007) and redundancy (Chopra & Khanna, 2014; Yao Hu *et al.*, 2008; Johnsen & Veen, 2012; Powley, 2009; Tierney, 2003; Winston, 2014). It is necessary to remark that other suggested elements may also be important attributes for organizational resilience. A resilient organization includes a mix of several capabilities and actions to be performed. It is this mix what makes an organization resilient (Gibson & Tarrant, 2010).

4. How is resilience assessed in practice?

In this section, we focus on the assessment of organizational resilience, and we study how it can be measured in practice. With this purpose, we reviewed over 30 works that propose tools or methods to assess organizational resilience. The number of articles reviewed is fewer than those reviewed for organizational resilience conceptualization because there are fewer works in the literature in this area. The review of these works indicates a lack of consensus about how to measure organizational resilience.

We can classify these works in the same three streams discussed in Section 3: those assessed using

the features of the organization, those assessed on the organizational outcomes, and those based on how the organization recovers from failure.

4.1. Assessment using the features of the organization

We classified the works in this area based on how the problem is assessed: using indicators, or other techniques (such as Fuzzy Cognitive Maps or assessment of organizational processes).

4.1.1. Measuring organizational resilience based on indicators

McManus *et al.* (2007) and Seville (2009) suggested 23 indicators followed by a description to evaluate four factors (situation awareness, management of keystone vulnerabilities, resilience ethos and adaptive capacity) that contribute to enhancing resilience. Whitehorn (2010) defined a subset of 15 indicators among the previous ones. He did not consider resilience ethos. The indicators proposed by Lee *et al.* (2013) are a subset of the ones suggested by McManus *et al.* (2007) and Seville (2009). They suggest to evaluate each factor using several items (see Lee *et al.*, 2013 for the list of items). They tested the model proposed by McManus *et al.* (2007), and found that using their sample and scale, the three factors model was not supported. They defined a new version with four factors and they suggested evaluating the factors through 73 items. However, their sample data and scale did not support this new model. They finally suggested a model with two factors (adaptive capacity and planning), 13 indicators and 53 items to be evaluated. Whitman *et al.* (2013) proposed a shorter version of the assessment tool by Lee *et al.* (2013). They suggested using just 13 items (one per indicator). They justified this short version based on two reasons: the low rate response they got while measuring resilience with a long questionnaire, and the correlation between the two assessment tools. The indicators proposed by Lee *et al.* (2013) included some of the characteristics for resilient organizations presented in sections 3.4, such as innovation and creativity (which matches improvisation capacity), collaboration (which matches with partnerships) or situation monitoring and reporting (which matches with situation awareness and the ability to anticipate events).

Other authors suggested different factors to assess resilience. For example, Starr *et al.* (2003) suggested using eight points: (1) organization transparency, (2) understanding of risk interdependencies, (3) development of viability studies in the organization, (4) alignment between the strategy in the organization and the objectives, (5) organizational knowledge about the efforts on resilience, (6) situation awareness, (7) how the organization uses situation awareness to react in a timely manner, and (8) measures to evaluate resilience and the progress of the organization. However, they did not define a scale for these eight points. Tompkins (2007) suggested using Robustness, Responsiveness, Resourcefulness, Rapidity, and Redundancy (the *Five R's*) to evaluate resilience. However, the items to be evaluated in each category were not discussed. Sanchis & Poler (2013) proposed to measure resilience based on the vulnerability of the organization, its adaptive capacity and recovery ability. Kohno *et al.* (2012) suggested evaluating resilience by taking into account the areas where the organization's facilities are located, the infrastructure the organization needs, the organization facilities and the supply chains. Apneseth *et al.* (2013) proposed to assess organizational resilience based on how good the organization is at monitoring, responding, anticipating and learning.

Somers (2009) suggested to measure the organizational resilience potential based on the six organizational resilience attributes defined in Mallak (1998a). These factors can be organized in three levels, and the overall resilience of the organization is evaluated from 1 (low) to 7 (high). Hollnagel (2010) proposed to assess resilience based on the ability of the organization to respond, monitor, anticipate and learn. Van Trijp *et al.* (2012a); Van Trijp *et al.* (2012b) suggested to evaluate resilience as a function of four factors: situation awareness, management of keystone vulnerabilities, adaptive capacity and quality. To evaluate these factors, they defined a performance measure based on the attributes they depend on. For example, to measure situation awareness, they evaluate: level of awareness about expectations, obligations and limitations; ability to look forward opportunities and potential crises; level of awareness about resource availability; ability to identify the crises and their consequences; the level of comprehension about the factors that trigger a crisis, and the level of comprehension about the minimum operating requirements for recovery. Rigaud *et al.* (2013) proposed evaluating resilience based on the capacity of the organization to (1) respond, (2)

monitor short-term developments and threats, (3) anticipate long-term threats and opportunities and (4) learn from past events. They suggested several indicators for each one. However, they did not describe the indicators proposed.

Other authors focus on specific sectors. For instance, Danes *et al.* (2009) determined resilience in family firms by evaluating the following items: (1) role clarity, (2) who has the decision authority, (3) ownership equality, (4) fairness of compensation, (5) failure to resolve firm conflicts, (6) unfair workloads and (7) competition for resources between the family and firm. Wicker *et al.* (2013) developed an organizational resilience scale to measure resilience in sports clubs. They develop items (ranged from 1 to 5) to evaluate each factor of resilience defined by Bruneau *et al.* (2003): robustness, redundancy, resourcefulness, and rapidity. For example, to measure rapidity, they evaluate the capability of the organization to achieve goals in a timely manner, adapt quickly to changing circumstances, meet priorities in a timely manner, restore services quickly during unexpected events and respond quickly to disruptive events.

4.1.2. *Measuring organizational resilience based on other techniques*

Other authors use Fuzzy Cognitive Maps (FCM) and Fuzzy sets to analyze these characteristics. For example, Grande & Trucco (2008) suggested analyzing the resilience of an organization using Fuzzy Cognitive Maps (FCM) to capture the relations between the variables that contribute to resilience. A FCM is a graph with edges and nodes representing causal relations between concepts. To study a Civil Defense System, they suggested evaluating 17 variables and their relations. Asgary *et al.* (2009) developed a Fuzzy-JESS Expert System based on 17 variables and a set of rules that takes into account these variables to determine the level of resilience in the business. The variables include the existence of a strategic plan, the existence of a business continuity committee or a number of potential hazards among others.

Aleksić *et al.* (2013) suggested assessing the organization resilience potential of SMEs using fuzzy sets, and evaluating the contributing factors for each business process. The importance of each factor in the process is weighted to calculate the resilience of the process. Then, the importance of

each process in the organization is also weighted to measure the overall organizational resilience. They proposed to evaluate internal factors (planning strategies, capability and capacity of internal resources, internal situation monitoring and reporting, human factors and quality), external factors (external situation monitoring and reporting and capability and capacity of external resources) and enabling resilience factors (design of the organization, detection potential, emergency response and safety management system).

Tadić *et al.* (2014); Macuzić *et al.* (2016) suggested to evaluate resilience using a fuzzy approach. They suggest the following steps: (1) creating an organizational reference model and to identify the factors that contribute to resilience, (2) weighing the importance of these factors and processes using a fuzzy approach, (3) determining linguistic expressions to evaluate these factors, (4) calculating the resilience factors' values using a fuzzy approach and (5) ranking the organizational resilience factors.

Other authors follow other approaches to assess the organizational characteristics. For example, Hu *et al.* (2008); Hu *et al.* (2009); Hu *et al.* (2010) proposed to solve an optimization problem in a network model of the enterprise to determine the effect of a disruption and the resilience of the enterprise. The objective is to understand the balance between operational redundancy and inventory redundancy to achieve resilience. They do not provide items to be analyzed to evaluate resilience. Caralli *et al.* (2010) proposed the CERT[®] Resilience Management Model to assess resilience. It defines 26 process areas with specific goals and practices. These areas include asset definition and management, resilience requirement development, risk management, people management or monitoring. The position of the organization in these processes can be used as a benchmark for identifying organizational capability for managing operational resilience.

4.2. Measurement based on the organizational outcomes

This stream is less popular, as fewer authors use this approach. For example, Watanabe *et al.* (2004) proposed to use the Operating Income to Sales to measure resilience. Dalziell & Mcmanus (2004) suggested to measure resilience based on Key Performance Index (KPIs) defined taking into

account the organization's objectives. However, these authors did not state the items, attributes, components or KPIs to be measured. Afgan (2010) proposed an index to measure resilience based on the change of company profit, the change of total company income, the change of product cost and the change of manpower (i.e. human resources availability). Markman & Venzin (2014) suggested to measure resilience based on the Return on Equity (ROE) and volatility. Jackson (2007) suggested to measure resilience potential based on the statistical correlation between minor and major incidents. He found that minor accidents are positively correlated to major accidents.

4.3. Measurement based on the organizational recovery

In this case, the authors measure resilience based on how the organization recovers from failure. The drawback is that the organization needs to suffer failures to assess its resilience. Therefore, this way to measure resilience is only valid after the organization has suffered some shocks. There are two main ways to measure resilience following this approach. Henry & Ramirez-Marquez (2010) suggest to measure resilience quantitatively as the ratio of Recovery and Loss. Here, Loss is the deterioration from the original state after the disruption and Recovery is the amount it bounces back from the disruptive state to the recovered state. The authors acknowledge that the limitation is to not to consider the money and time to recover. They do not consider what we should evaluate to measure loss and recovery. Erol, Henry & Sauser (2010); Erol, Henry, Sauser, *et al.* (2010) proposed to measure resilience based on recovery time, level of recovery, initial vulnerability and potential loss averted. However, they do not indicate how to assess these items

5. Discussion and conclusions

Following the guides in Suddaby (2010) to construct clarity in Theories of Management and Organization, this section introduces a conceptualization of resilience. We also present a Maturity Model for Organizational Resilience (MMOR). Finally, we present basic dimensions to measure organizational resilience.

5.1. Organizational resilience conceptualization

From our analysis on how organizational resilience is understood presented in section 4, we can see that, at present, there is no clear conceptualization of organizational resilience. Following Suddaby (2010), a clear conceptualization should have a good definition, scope conditions or contextual circumstances, semantic relations with other concepts, and coherence and logical consistency.

We propose a conceptualization that integrates the three views about resilience presented in section 4. *Resilience, at the organizational level, is the measurable combination of characteristics, abilities, capacities or capabilities that allows an organization to withstand known and unknown disturbances and still survive.*

Resilience is not a static concept. The degree of resilience an organization evolves over time. An organization evolves from fragile to antifragile, and resilience is a middle estate in this evolution (Taleb, 2012). Focusing on how well the organization has developed its abilities to survive in changing or turbulent environments, we suggest a four-level Maturity Model for Organizational Resilience – MMOR- (Figure 3). The organization can be at any of the following levels: fragile, robust, resilient and antifragile.

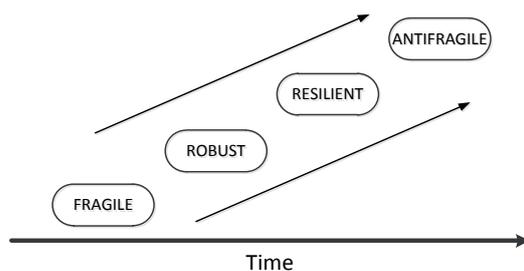


Figure 3. Four-level Maturity Model for Organizational Resilience (MMOR).

The organization evolves from one level to another over time based on the improvement on its abilities, characteristics or capabilities to deal with disturbances. A fragile organization is not able to withstand changing environments: it collapses. A robust organization is able to survive to some set of changes in the environment. However, if these changes are outside the designed parameters, the organization will probably collapse. A resilient

organization is not only robust, but it is also able to survive to unforeseen events. An antifragile organization is able to not only to survive, but also to prosper or thrive in turbulent environments.

Regarding the attributes, elements or characteristics for resilience, we propose the ones presented in section 3.3 as an initial combination: building situation awareness, managing organization’s vulnerabilities, having resources, improvisation capacity, ability to anticipate events, agility, learning capacity, collaboration, resilient individuals, flexibility, robustness and redundancy.

Future research lines in this area should aim to develop a framework to understand how good the organization is dealing with turbulent environments. To be consistent with the previous literature, the organization should be classified in one of the following four levels: fragile, robust, resilient or antifragile. The characteristics and attributes the organization has in each of these levels should be identified. As we proposed in our definition of organizational resilience, these attributes must be measurable to be able to assess resilience and provide an estimate of the resilience potential. These works should combine theoretical and empirical work to test the results.

5.2. Discussion about organizational resilience assessment

After reviewing how to measure organizational resilience, we consider that *two main dimensions to evaluate organizational resilience* should coexist. The first one should aim to provide an *estimate of organizational resilience potential* (i.e. evaluate resilience before a disruptive event occurs). The second one should aim to *evaluate the level of resilience an organization has exhibited after a disruptive event has occurred.*

To provide an estimate of organizational resilience potential, we suggest assessing organizational resilience based on the features of the organizational (Section 4.1). The organizational elements, attributes or characteristics to be evaluated should include, at least, the ones presented in section 5.1.

To measure the level of resilience an organization has exhibit after a disruptive event, we recommend assessing organizational resilience based on how the organization recovers from failure. We propose

evaluating a recovery ratio that measures the organizational losses against the recovery and the recovery time. The recovery ratio should include both organizational capabilities and organizational performance. Measuring resilience after a disruptive event has occurred will help to provide better estimates of the resilience potential studying the correction between the two measures.

We want to clarify that our aim is to provide the basis to build an organizational resilience measurement scale. We are not focused on providing the measurement scale.

We suggest that future research directions in this area should aim to identify a common framework that includes indicators and a scale to measure not only organizational resilience potential but also the maturity level the organization has to deal with turbulent environments. Although there are some works in this research direction, the works that measure resilience do not take into account the antifragility concept and vice versa. For example, there are some criteria to measure antifragility (Johnson & Gheorghe, 2013; Kennon, Schutte, Lutters, 2015). However, the link to resilience and the other levels has not been analyzed yet. A scale to measure the level of resilience after a disruptive event has occurred should also be provided.

Additionally, we also suggest that future research lines should aim to identify paths to develop resilient and antifragile organizations. Following this research line, several works have started to address the issue. For example, Ruiz-Martin *et al.* (2017) proposed to apply the Viable System Model to design resilient organizations. Ruiz-Martin *et al.* (2015) remarked the importance of communication systems in organizational resilience and suggested evaluating the communication system using network theory.

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Tolk & Johnson IV (2013) proposed to develop antifragile systems focusing on their components and interactions and Jones (2014) stated that a change in the way we design systems is needed. Tseitlin (2013) explained how antifragility is developed in a real organization: Netflix. This research area has just started its development and more theoretical and empirical research is needed.

5.3. Further discussion about organizational resilience

As discussed in the introduction, the study of resilience covers different related areas. Future research directions should aim to identify these relations. Some questions to be answered are: (1) What is the lowest level of resilience? Is it having resilient individuals? (2) What kinds of resilience (i.e. infrastructure resilience, resilient individual, etc.) affect organizational resilience and how? (3) What kind of resilience (i.e. community resilience, city resilience, and so on) are influenced by organizational resilience? and (4) How all these areas of resilience are integrated to develop a more resilient world?

In section 5.1, we introduced the MMOR model. Future research direction should also aim to investigate if this concept and the four-level MMOR to develop antifragile organizations (i.e. from fragile to antifragile organizations) are also applicable to the other concepts such as infrastructures, individuals, communities or territories.

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