International Journal of Production Management and Engineering

https://doi.org/10.4995/ijpme.2017.7423
Received 2016-12-09 Accepted: 2017-06-21

# Aligning Organizational Pathologies and Organizational Resilience Indicators

**Manuel Morales Allende[a1], Cristina Ruiz-Martin[a2*], Adolfo Lopez-Paredes[a3] and Jose Manuel Perez Ríos[a4]**

[a]INSISOC. Universidad de Valladolid. Spain

[a1] *manuelmoralesallende@gmail.com,* [a2] *cruiz@eii.uva.es,* [a3] *aparedes@eii.uva.es,* [a4] *rios@uva.es*

**Abstract:** Developing resilient individuals, organizations and communities is a hot topic in the research agenda in Management, Ecology, Psychology or Engineering. Despite the number of works that focus on resilience is increasing, there is not completely agreed definition of resilience, neither an entirely formal and accepted framework. The cause may be the spread of research among different fields. In this paper, we focus on the study of organizational resilience with the aim of improving the level of resilience in organizations. We review the relation between viable and resilient organizations and their common properties. Based on these common properties, we defend the application of the Viable System Model (VSM) to design resilient organizations. We also identify the organizational pathologies defined applying the VSM through resilience indicators. We conclude that an organization with any organizational pathology is not likely to be resilient because it does not fulfill the requirements of viable organizations.

**Key words:** Organizational Resilience, Viable System Model, Organizational Pathologies.

## 1. Introduction

Building resilience is a key topic in many research fields such as Management, Engineering, Psychology or Ecology. Governments are investing resources to develop resilient institutions, communities, organizations and individuals. For example, the Australian Government developed a tool to assess organizational resilience. The proposal is a questionnaire based on thirteen indicators to measure organizational resilience potential. They classify the indicators on three factors: leadership and culture, networks and partnerships and change readiness. The US Department of Homeland Security relates resilience to three main concepts: adaptation to changing conditions, withstand disruptions and ensure rapid recovery. The European Commission (2017) for the Horizon 2020 program has identified "state and societal resilience" among the top five priorities of the European Union's external actions. The European Union Action Plan for Resilience (European Commission 2016) outlines three priorities in the area of resilience: (1) support the development and implementation of national resilience capacity, (2) promote innovation and learning capacities to advocate resilience and (3) develop tools and methodologies to improve and measure resilience.

Being broadly and widely used the term resilience, there is not entire consensus about its definition. Some authors state that resilience was first introduce in Psychology (Coutu, 2002). Other authors (Henry

**To cite this article:** Morales Allende, M., Ruiz-Martin, C., Lopez-Paredes, A., Perez Ríos, J. M. (2017). Aligning Organizational Pathologies and Organizational Resilience Indicators. *International Journal of Production Management and Engineering, 5*(2), 107-116. https://doi.org/10.4995/raet.2017.7423

and Ramirez-Marquez, 2010; Annarelli and Nonino, 2016) say that the concept resilience was popularized after Holling (1973), "Resilience and Stability of Ecological Systems". Psychology and Ecology are not the only research fields where researches have focused their attention on resilience. It has also been studied in other fields including Management (Disaster Management, Organization Management or Community Management), Sociology or Engineering.

The dispersion of the research among so many fields may be the cause of a lack of widely accepted definition of resilience. Despite the research in different fields seems to be isolated from each other, they are not. To build resilient organizations we need resilient individuals (Mallak, 1997; Doe, 1994; Biggs *et al.,* 2012), resilient supply chains (Sheffi, 2007) and resilient infrastructure (Bell, 2002; Erol *et al.,* 2009). To build resilient organizations we also need to apply resilient engineering principles (Righi *et al.,* 2015). Resilient communities (Kendra and Wachtendorf, 2003; Lee *et al.,* 2013) and resilient territories (Gilly *et al.,* 2014) are built over resilient organizations.

In this work, we will focus on organizational resilience. Our contribution is to establish a relation between organizational resilience and other theories in Management. Specifically, we relate the organizational pathologies identified applying the Viable System Model (VSM) and organizational resilience indicators. Grounded in the common properties that resilient and viable organization share, we support that an organization with any organizational pathology cannot be considered resilient because it is not viable. Our final objective is to improve the level of organizational resilience. The identification of the pathologies will give the organization the path to improve its viability and therefore its resilience.

The rest of the paper is organized as followed. In section 2, the concept of organizational resilience, the factors that contribute to organizational resilience and how it is measured are reviewed. In section 3, the application of the VSM to identify organizational pathologies is explained. In section 4, the application of the VSM and the identification of organizational pathologies to design resilient organizations are defended. In section 5, the results of the research are presented. Some organizational pathologies and the scores obtained in different resilience indicators are aligned. Finally, in section 6, the conclusions of this work are presented.

## 2. Organizational Resilience

Despite there is not a widely and accepted definition of organizational resilience, we agree with the authors that consider organizational resilience as an ability, capacity or capability to deal with disruptive events (Mallak, 1997; Hamel and Valikangas, 2003; Starr *et al.,* 2003; Sheffi and Rice Jr., 2005; Jackson, 2007; Tillement *et al.,* 2009; Hollnagel, 2010; Lengnick-Hall *et al.,* 2011; Manyena, 2006; Annarelli and Nonino, 2016; Linnenluecke *et al.,* 2012).

To deal with disruptive events organizations need a set of abilities or capabilities. We have reviewed the works that identify those abilities and we have found that there is not a consensus. In Ruiz-Martin *et al.* (2017a), the authors identified the most common and repeated characteristics of resilient organizations in the literature. These characteristics include the capability of: building situation awareness, managing organization's vulnerabilities, having resources, having improvisation capacity, being able to anticipate to events, being agile, having learning capacity, collaboration, having resilient individuals and being flexible and redundant.

Regarding to the measurement of organizational resilience there are two main streams: the measurement of organizational resilience potential and the measurement of resilience after a disruptive event has occurred (Ruiz-Martin *et al.,* 2017b).

The assessment of organizational resilience potential is usually based on evaluating the characteristics or abilities an organization possess. Despite there is a broad literature about organizational resilience indicators (Horne III and Orr, 1998; Bhamidipaty *et al.,* 2007; Somers, 2009; Sanchis and Poler, 2013; Lee *et al.,* 2013; Seville 2009; Whitman *et al.,* 2013), we have chosen the indicators proposed by Lee *et al.* (2013) because they provide a complete benchmark tool to do the evaluation process. They evaluate the organizational resilience potential based on a questionnaire with 53 items. Each item is evaluated based on an eight-point scale. The lower score is achieved if the organization strongly disagrees with the statement in the item. The higher score is obtained when the organization strongly agree with the statement. The 53 items are classified in to 13

 

indicators. The indicators are grouped in two factors: adaptive capacity and planning.

The indicators included in adaptive capacity are:

- Minimization of silos. It is related to the minimization of barriers in the organization, especially those ones related to communication.
- Internal resources. The organization has enough resources to conduct its business as usual, but it is also able to provide extra resources when needed.
- Staff engagement and involvement. The staff understands the link between their work, the resilience of the organization and its success. Moreover, the staff is encouraged to use their problem solving capabilities.
- Information and knowledge. The information is available when needed and stored in different locations. The staff is flexible, so different people can fill key roles.
- Leadership. There is a good leader in the organization. The organization strategies and programs are continuously reviewed.
- Innovation and creativity. The use of novel ways to solve problems is encouraged and rewarded in the organization.
- Decision making. People have the authority to make decision based on their skills. During crisis, authority is delegated to be able to respond to the crisis.
- Situation monitoring and reporting. Staff is encouraged and rewarded for performing monitoring activities. Early warning signals are rapidly reported to organizational leaders.

The indicators included in planning are:

- Planning strategies. There are plans to manage organization vulnerabilities.
- Participation in exercise. There are simulacrums in the organization to practice and evaluate the plans.
- Proactive posture. The organization is prepared to respond to early warning signals.
- External resource. The organization has a plan to access resources from other organizations when needed.
- Recovery priorities. The priorities are set and the organization understands its minimum operating requirements.

Analyzing the 13 indicators, we get an idea of how the organization is prepared to respond to a crisis.

However, the resilience of the organization will depend on the kind of risk it is dealing with. The level of resilience the organization has exhibited cannot be measured until the risk has occurred. To measure the level of resilience after a disruptive event, Henry and Ramirez-Marquez (2010) propose to evaluate the level of recovery of the organization against its loses. Erol, Henry and Sauser (2010); Erol, Henry, Sauser, *et al.* (2010) also include the recovery time, the initial vulnerability and the potential loss averted.

## 3. The Viable System Model (VSM) and Organizational Pathologies

The VSM was developed by Beer (1981). It is a scientific framework, based on organizational cybernetics, which establishes the necessary and sufficient conditions for the viability of a system. According to the VSM a viable system must have the capacities of self-regulation, learning, adaptation, and evolution

In the management field, it is applied to the design and study of organizations and its processes (Pérez Ríos, 2012). The aim is to design viable organizations. It means to design organizations able to survive regardless the changes in its environment.

According to Beer, the viability of a system is based on the existence of a set of functional systems in the organization and a set of relationships among these functional systems and the environment. The systems and the relations among them are represented in Figure 1. An important aspect of the viability of a system is its recursive property: all viable systems contain viable systems and are themselves contained in viable systems.

Each of the systems defined by Beer has a specific functionality on the organization. *System 1* is in charge of the production and delivery. It produces the goods or services in the organization. It is composed by several operational units. They can be suborganizations or different divisions in the company. *System 2* has to guarantee a harmonic and stable functioning of the organizational units in *System 1*. The main role of *System 3* is to optimize the functioning of the whole set of operational units that compose system. It is responsible for the "here and now" of the organization. *System 4* has to

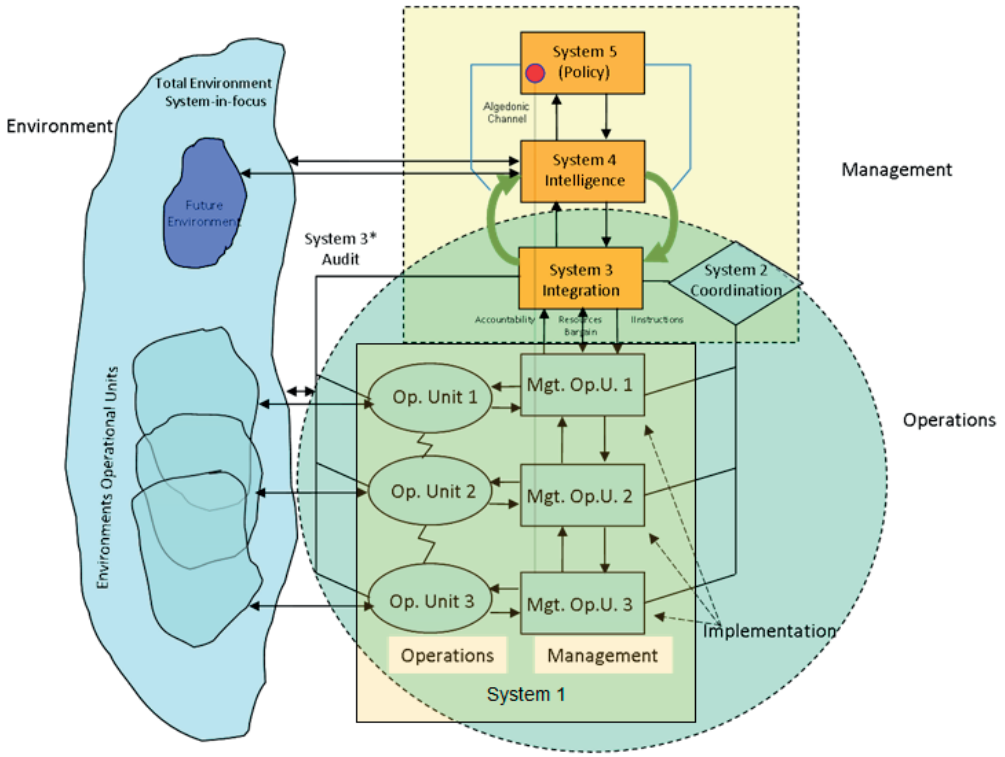


**Figure 1.** Viable System Model, adapted from Beer, 1981 (Pérez Ríos, 2012). Used with author permission.

monitor the organization environment, focusing on the "outside and then" of the organization. Its aim is to be prepared for changes. *System 5* is responsible for defining the ethos, the vision and the identity of the organization. It takes care of the normative decisions.

According to Pérez Ríos (2012), any shortage on these systems or in their communication mechanisms is translated into different organizational pathologies. Any organizational pathology may cause the disappearance of the organization, at least as an independent entity.

Pérez Ríos (2012) classifies the organizational pathologies into three main groups: structural pathologies, functional pathologies and information pathologies.

Structural pathologies are related to how the organization is designed and how it copes with environmental variability. There are four structural pathologies: non-existence of vertical unfolding, lack of first recursion levels, lack of middle recursion levels and entangled vertical unfolding with interrelated memberships.

Functional pathologies are related to the adequacy of the organization's systems to the prescriptions made by the VSM. Functional pathologies are classified based on the system they affect and those ones that affect the whole organization.

Functional pathologies related to system 5 are: ill-defined identity, institutional schizophrenia, lack of metasystem (i.e. collapse of system 5 in system 3) and inadequate representation in higher levels. Functional pathologies related to system 4 are headless chicken (i.e. the organization does not monitor the environment and is not able to adapt to changes) and dissociation between system 4 and 3. Functional pathologies related to system 3 are: inadequate management style, schizophrenic system 3, week connection between system 3 and 1 and hypertrophy of system 3. The functional pathology related to system 3* is the lack or insufficient development this system. System 2 can present two pathologies: disjointed behavior within system 1 and authoritarian system 2. The pathology related to system 1 are "autopoietic beasts" (i.e organizations that only focus on individual goals and do not take into account the whole) and dominance

 

of system 1. The pathologies related to the whole organization are organizational autopoietic beasts and lack of metasystem.

Information system and communication channel pathologies are related to the malfunctioning of the communication and information system. Information pathologies are the lack of information systems, the fragmentation of information systems and insufficient or lack off key communication and algedonic channels.

## 4. Applying the Viable System Model to Design Resilient Organizations

In Ruiz-Martin *et al.* (2017), the authors discuss the relation between resilient and viable organizations. They highlight that one of the aims of resilient organizations is to recover from challenges or disruptive events. Taking into account the definition of a viable organization (i.e. those organizations able to survive despite changes in the environment), a resilient organization needs to be also viable. Moreover, they also found that resilient organization should have, at least, the capacities of viable organizations (self-regulation, learning, adaptation, and evolution).

They conclude that resilient organizations fit the VSM principles and therefore it is a valid framework to design resilient organizations. More specifically, they propose the use of the methodological framework introduced by Pérez Ríos (2010) to design a resilient organization. The methodological framework is structured into four steps. The first step is to recognize the identity and the purpose of the organization. The second step is to identify how the organization deals with environmental complexity and to design the vertical structure of suborganizations. The third step is to analyse the proposed structure and check that all the needed elements for the viability of the organization are represent. The final step is to ensure the coherence among the suborganizations identities and purposes and to check the suborganizations connections.

In this work, we go a step forward and analyze the organization following both the organizational resilience approach and the VSM framework. We determine the level of organizational resilience potential based on resilience indicators. For this purpose, we use the benchmark tool designed by Lee *et al.* (2013) because they provide a complete questionnaire to do the assessment. We identify organizational pathologies using the score obtained in the resilience questionnaire. We support that the identification and handling of organizational pathologies is the path to improve organizational resilience potential.

In section 5, we explain the relation between the indicators proposed by Lee *et al.* (2013) to evaluate organizational resilience potential and the organizational pathologies identified by Pérez Ríos (2012) applying the VSM. We defend that the identification of the pathologies will give the organization the path to improve its viability and therefore its resilience.

## 5. Identification of Organizational Pathologies Using Resilience Indicators

In Table 1, we present the relation between the indicators proposed by Lee *et al.* (2013) and the organizational pathologies introduced by Pérez Ríos (2012). In the table, we represent with an "x" the set of indicators that will be used to diagnose each pathology. The organization is likely to suffer the pathology if the score on the highlighted indicators is low.

To relate the resilience indicators with the organizational pathologies, we have analyzed the questions proposed by Lee *et al.* (2013) to measure each indicator. If a low score in any of the proposed questions to evaluate an indicator can be used as evidence of an organizational pathology, we related the indicator with the pathology with an "x" in Table 1.

The statements we make along this section to defend the relation between the indicator and the pathology are the authors' hypothesis based on the organizational properties evaluated by the indicators and the literature regarding the organizational pathologies introduced by Pérez Ríos (2012).

**Identification of structural pathologies**

The structural pathologies can be identified by a low score in the following indicators: leadership, decision making and planning strategies.

A low score on leadership reveals a lack of a good organization structure. A well-designed organization should have clear leadership positions. If the score on decision-making is low, it will probably mean that the decisions are not taken at the right levels. Not having a good score on planning strategies would mean that there are no plans to deal with environmental variability, that the plans does not fit the organization purposes or that there is a lack of planning reviews to keep plans up to date.

Despite we cannot detect which specific structural pathology the organization has, these indicators reveal a lack of organization design adequacy.

**Identification of functional pathologies**

As we mentioned in section 3, functional pathologies are related to the adequacy of the organization's systems to the prescriptions made by the VSM. They are classified based on which system the pathologies affect.

Functional pathologies related to system 5

*Ill-defined identity* and *Institutional schizophrenia* is noticed by a low score in the following indicators: minimization of silos, leadership, decision-making, planning strategies and recovery priorities. If the identity (vision and mission) of the organization is not well defined, there will be undesirable behaviors, a lack of leadership according to the organizational objectives and a lack of proper decision-making strategies and role assignment. Moreover, it is not possible to define the organization strategy and recovery priorities if the vision, mission and objectives of the company are not defined. If the organization objectives are not defined, it is very luckily that system 5 constantly change its opinion based on what is more convenient at each moment without thinking long term.

*Lack of metasystem* is identified through a low score in the following indicators: leadership and decision-making. The decision are not taken by the right person and the leader of the "here and now" in the organization does not have the information and power to take the decisions.

*Inadequate representation in higher levels* is observed by a low score in leadership and information and knowledge. The knowledge is not properly distributed among different organizational levels. The leaders cannot perform well in their job because of the disconnection and lack of information.

Functional pathologies related to system 4

*Headless chicken* (i.e. the organization does not monitor the environment and is not able to adapt to changes) is noticed by a low score in innovation and creativity, situation monitoring and reporting, planning strategies and proactive posture. A lack of a well design system 4 carries a mismanaging of the "outside and then" in the organization. It is translated in a lack of innovative and creative solutions to adapt to the environment, an insufficient monitoring of the environment and therefore a lack of information to develop sound strategies.

*Dissociation between system 4 and 3* is observed by a low score in internal resources, information and knowledge, situation monitoring and reporting, planning strategies and recovery priorities. The resources would not be used properly as system 3 and 4 would apply their own criteria. The incoordination between the two systems would carry lack of information sharing; the strategies and the recovery priorities may be incoherent. Moreover, system 3 would not have information about the evolution of the environment to adapt for the future.

Functional pathologies related to system 3

*Inadequate management style* and *Hypertrophy of system 3* are noticed by a low score in information and knowledge because the information is not properly transmitted among the system. System 3 does not absorb enough environment variability. The score in leadership, decision making and planning strategies would also be low due to the over involvement in task that are not among system 3 competencies.

*Schizophrenic system 3* is manifested by a low score in internal resources, information and knowledge and proactive posture. The low score is due to the constant changes made by system 3 in the decisions taken. There would be incongruences in the resource assignments, in the information transmitted or in the criteria to detect changes in the environment based on early warning signals.

*Weak connection between system 3 and 1* is perceived by a low score in internal resources, information and knowledge, leadership, situation monitoring and reporting and recovery priorities. There would be internal competing for resources in system 1, each

 

**Table 1.** Relation of Lee *et al.* (2013) organizational resilience indicators and Perez Ríos (2012) organizational pathologies.

| Indicators / Pathologies | Adaptive capacity | | | | | | | Planning | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Minimization of silos | Internal resources | Staff engagement and involvement | Information and knowledge | Leadership | Innovation and creativity | Decision making | Situation monitoring and reporting | Planning strategies | Participation in exercise | Proactive posture | External resource | Recovery priorities |
| **Structural pathologies** | | | | | | | | | | | | | |
| Non-existence of vertical unfolding | | | | | x | | x | | x | | | | x |
| Lack of first recursion levels | | | | | x | | x | | x | | | | x |
| Lack of middle recursion levels | | | | | x | | x | | x | | | | x |
| Entangled vertical unfolding with interrelated memberships | | | | | x | | x | | x | | | | x |
| **Functional pathologies related to system 5** | | | | | | | | | | | | | |
| Ill-defined identity | x | | | | x | | x | | x | | | | x |
| Institutional schizophrenia | x | | | | x | | x | | x | | | | x |
| Lack of metasystem | | | | | x | | x | | | | | | |
| Inadequate representation in higher levels | | | | x | x | | | | | | | | |
| **Functional pathologies related to system 4** | | | | | | | | | | | | | |
| Headless chicken | | | | | | x | | x | x | | x | | |
| Dissociation between system 4 and 3 | | x | | x | | | | x | x | | | | x |
| **Functional pathologies related to system 3** | | | | | | | | | | | | | |
| Inadequate management style | | | | x | x | | x | | x | | | | |
| Schizophrenic system 3 | | x | | x | | | | | | | x | | |
| Week connection between system 3 and 1 | | x | | x | x | | | x | | | | | x |
| Hypertrophy of system 3 | | | | x | x | | x | | x | | | | |
| **Functional pathologies related to system 3*** | | | | | | | | | | | | | |
| Lack or insufficient development of system 3* | x | | x | | x | | | | x | x | | | x |
| **Functional pathologies related to system 2** | | | | | | | | | | | | | |
| Disjointed behavior within system 1 | | x | | x | | | x | x | | | | | x |
| Authoritarian system 2 | | | x | | x | | | | | | | | |
| **Functional pathologies related to system 1** | | | | | | | | | | | | | |
| "Autopoietic beasts" | x | x | | x | x | | | | x | | | | x |
| Dominance of system 1 | x | x | | x | x | | | | x | | | | x |
| **Functional pathologies related to the whole organization** | | | | | | | | | | | | | |
| Organizational autopoietic beasts | | | x | | x | | x | | x | | | | |
| Lack of metasystem | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Information system and communication channel pathologies** | | | | | | | | | | | | | |
| Lack of information systems | x | x | | x | | x | | | | | | | |
| Fragmentation of information systems | x | x | | x | | x | | | | | | | |
| Lack of key communication channels | x | x | | x | | x | | | | | | | |
| Lack of or insufficient algedonic channels | x | x | | x | | x | | | | | | | |

operation unit would set their own recovery priorities, the information flow and knowledge sharing among system 1 components would be tense due to the lack of authority, and the employees in system 1 would perceive a lack of leadership. Additionally, system 3 would not be able to monitor the well function of system 1 and set new guidelines with needed.

Functional pathologies related to system 3*

*The lack or insufficient development of system 3** is observed by a low score in minimization of silos, staff engagement and involvement, leadership, planning strategies, participation in exercises and recovery priorities. The malfunctioning of audits would difficult the homogenization process in organizational behaviors and will show the lack of commitment of the staff with the work methodologies set in the organization. Moreover, this pathology may be caused by a weak leadership or lack of planning strategies to develop the audit system. If there is no audit there is no guarantee that the recovery priorities in system 1 are well implemented and that the participation in exercises is done.

Functional pathologies related to system 2

*The disjointed behavior within system 1* is manifested by a low score in internal resources, information and knowledge, decision making, situation monitoring and reporting and recovery priorities. If the system 2 does not transmit the decision made in system 3, operational units in system 1 will make their own decision, set their own recovery priorities and will fight for resources.

*An authoritarian system 2* is noticed by a low score in staff engagement and involvement and leadership. The staff is not motivated and they perceive that the organization is too bureaucratic. The staff does not understand the purpose of the tasks they are assigned. They perceive them as a waste of time. The units in system 1 may feel that the organization lacks from a leader.

Functional pathologies related to system 1

*The "autopoietic beasts* and *dominance of system 1* pathologies are identified by a low score in minimization of silos, internal resources, information and knowledge, leadership, planning strategies and recovery priorities. Each operational unit has its own goals and they do not care about the whole organization. The same occurs when the system 1 dominates the whole organization. The low score in the indicators would be due to the different ways of working, the fights for internal resources, the lack of leadership that controls system 1, the lack of information shearing among operational units or organization system components, the lack of coherence in planning strategies and the establishment if individual recovery priories.

Functional pathologies related to the whole organization

*Organizational autopoietic beasts* are revealed by a low score in staff engagement and involvement, leadership, decision making and planning strategies. The low score is due to the existence of systems that does not cooperate with each other and they just focus on their individual objectives. This behavior would be translated in low staff engagement, leaders that are overlapping other staff responsibilities and decision would not be taken at the right level. Additionally the hypertrophic system would have too much power when developing the organization strategies.

*Lack of metasystem* is mainly recognized by a low score in planning strategies. If the organization lacks from metasystem there is nobody in charge of setting organizations strategies and priorities. We consider that an organization without metasystem is luckily to have a low score in every indicator.

**Identification of information system and communication channel pathologies**

Information system and communication channel pathologies are detected by a low score in the following indicators: minimization of silos, internal resources, information and knowledge and innovation and creativity.

The lack of well-defined communication structures and communication channels would carry the inability to track staff behaviors and to correct undesirable ones. Therefore, the score in the minimization of silos indicator would be low. There would also be conflict to get the common resources (i.e. a low score in internal resources). The important information and instructions would not be transmitted on time and it would be more difficult to share the knowledge across the organization (i.e. low score in information and knowledge). The score in innovation and creativity would also be low as these processes require the involvement of different

 

organization departments and good communication is a key factor for their success.

As we explained in structural pathologies, the indicators are not enough to specify the type of information pathology, but they provide evidences of a malfunctioning of the organization in this area.

## 6. Conclusion

In this work, we have studied the alignment of organizational resilience assessment through indicators and some organizational pathologies already identified in the management literature. We have presented how we can identify a path to improve organizational resilience combining an analysis based in resilience indicators and the VSM methodological framework. The VSM provides a formal methodological framework that will support the organizations to be more resilient.

Though a questionnaire to the organization, we obtain a score in several indicators that reflect the organizational resilience potential. The score in these indicators is used to identify the pathologies an organization can suffer according to the VSM. We defend that treating these pathologies, the organization would improve its viability and therefore its level of resilience.

Future research lines will aim to validate the proposed relation between the resilience indicators and the pathologies of the organization. We will provide the questionnaire to different organizations to analyze the relation between the scores they obtain and the pathologies they present. We will also use the empirical study to establish score thresholds for the different pathologies. The "x" in Table 1, would be translated in a score range.

### Acknowledgements

This research has been partially supported by Banco Santander and Universidad de Valladolid.

## References

Annarelli, A., Nonino, F. (2016). Strategic and operational management of organizational resilience: Current state of research and future directions. *Omega, 62*: 1–18. https://doi.org/10.1016/j.omega.2015.08.004

Australian Government, Organizational Resilience. Available at: https://www.organisationalresilience.gov.au/Pages/default.aspx [Accessed July 12, 2017].

Beer, S. (1981). *Brain of the firm: the managerial cybernetics of organization*, J. Wiley New York.

Bell, M. (2002). The five principles of organizational resilience. *Gartner Research. [Online]*, 2–4.

Bhamidipaty, A., Lotlikar, R., Banavar, G. (2007). RMI: a framework for modeling and evaluating the resiliency maturity of IT service organizations. In *IEEE International Conference on Services Computing (SCC 2007)*. Salt Lake City, UT, 300–307. https://doi.org/10.1109/SCC.2007.94

Biggs, D., Hall, C.M., Stoeckl, N. (2012). The resilience of formal and informal tourism enterprises to disasters: Reef tourism in Phuket, Thailand. *Journal of Sustainable Tourism*, *20*(5): 645–665. https://doi.org/10.1080/09669582.2011.630080

Coutu, D.L. (2002). How resilience works. *Harvard business review*, *80*(5), 46-56.

Doe, P.J. (1994). Creating a resilient organization. *Canadian Business Review*, *21*: 22.

Erol, O., Henry, D., Sauser, B., Manosouri, M. (2010). Perspectives on measuring enterprise resilience. In *2010 IEEE International Systems Conference Proceedings, SysCon 2010*: 587-592. https://doi.org/10.1109/systems.2010.5482333

Erol, O., Henry, D., Sauser, B. (2010). Exploring resilience measurement methodologies. In *20th Annual International Symposium of the International Council on Systems Engineering, INCOSE 2010*: 302–322. https://doi.org/10.1002/j.2334-5837.2010.tb01072.x

Erol, O., Mansouri, M., Sauser, B. (2009). A framework for enterprise resilience using service oriented architecture approach. In *2009 IEEE International Systems Conference Proceedings*: 127–132. https://doi.org/10.1109/SYSTEMS.2009.4815785

European Commission (2016). Building Resilience : The EU's approach. Available at: http://ec.europa.eu/echo/files/aid/countries/factsheets/thematic/resilience_en.pdf [Accessed July 12, 2017].

European Commission (2017). Resilience as a strategic priority of the external action of the EU. Roadmap - Ares(2017)1137007. Available at: https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-1137007_en [Accessed July 12, 2017].

Gilly, J.P., Kechidi, M., Talbot, D. (2014). Resilience of organisations and territories: The role of pivot firms. *European Management Journal*, *32*(4): 596–602. https://doi.org/10.1016/j.emj.2013.09.004

Hamel, G., Valikangas, L. (2003). The quest for resilience. *Harvard business review*, *81*(9): 52–65.

Henry, D., Ramirez-Marquez, J.E. (2010). A generic quantitative approach to resilience: A proposal. In *20th Annual International Symposium of the International Council on Systems Engineering, INCOSE 2010*: 291–301. https://doi.org/10.1002/j.2334-5837.2010.tb01071.x

Holling, C.S. (1973). Resilience and Stability of Ecological Systems. *Annual review of ecology and systematics*: 1–23. https://doi.org/10.1146/annurev.es.04.110173.000245

Hollnagel, E. (2010). How Resilient Is Your Organisation? An Introduction to the Resilience Analysis Grid (RAG). *Sustainable Transformation: Building a Resilient Organization*.

Horne III, J.F., Orr, J.E. (1998). Assessing behaviors that create resilient organizations. *Employment Relations Today*, *24*(4): 29–39.

Jackson, S. (2007). A multidisciplinary framework for resilience to disasters and disruptions. *Journal of Integrated Design and Process Science*, 11(2): 91–108.

Kendra, J., Wachtendorf, T. (2003). Elements of resilience after the World Trade Center disaster: reconstituting New York City's Emergency Operations Centre. *Disasters*, *27*(1): 37–53. https://doi.org/10.1111/1467-7717.00218

Lee, A.V, Vargo, J., Seville, E. (2013). Developing a Tool to Measure and Compare Organizations' Resilience. *Natural Hazards Review*, 14: 29–41. https://doi.org/10.1061/(ASCE)NH.1527-6996.0000075

Lengnick-Hall, C.A., Beck, T.E., Lengnick-Hall, M.L. (2011). Developing a capacity for organizational resilience through strategic human resource management. *Human Resource Management Review*, *21*(3): 243–255. https://doi.org/10.1016/j.hrmr.2010.07.001

Linnenluecke, M.K., 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. https://doi.org/10.1002/bse.708

Mallak, L.A. (1997). How to build a resilient organization. In *Proceedings of the Industrial Engineering Solutions 1997 Conference*. Miami, 170–177.

Manyena, S.B. (2006). The Concept of Resilience Revisited. *Disasters*, *30*(4): 433–450. https://doi.org/10.1111/j.0361-3666.2006.00331.x

Pérez Ríos, J. (2012). *Design and Diagnosis for Sustainable Organizations: The Viable System Method*, Springer Heidelberg, New York, Dordrecht, London.

Pérez Ríos, J. (2010). Models of organizational cybernetics for diagnosis and design. *Kybernetes*, *39*(9/10): 1529-1550. https://doi.org/10.1108/03684921011081150

Righi, A.W., Saurin, T.A., Wachs, P. (2015). A systematic literature review of resilience engineering: Research areas and a research agenda proposal. *Reliability Engineering & System Safety*, *141*: 142-152. https://doi.org/10.1016/j.ress.2015.03.007

Ruiz-Martin, C., Pérez Rios, J.M., *et al.* (2017). The Application of the Viable System Model to Enhance Organizational Resilience. In *Advances in Management Engineering:* 88–100. https://doi.org/10.1007/978-3-319-55889-9_5

Ruiz-Martin, C., Lopez-Paredes, A., Wainer, G. (2017). Organizational Resilience: Conceptualization and Measurement. *Submitted*.

Sanchis, R., Poler, R. (2013). Definition of a framework to support strategic decisions to improve Enterprise Resilience. In *IFAC Proceedings Volumes (IFAC-PapersOnline)*: 700–705. https://doi.org/10.3182/20130619-3-RU-3018.00600

Seville, E. (2009). Resilience: Great Concept... But What Does it Mean for Organizations? *Tephra*, July: 9–14.

Sheffi, Y. (2007). Building a Resilient Organization. *The Bridge - National Academy of Engineering*, 37(1): 30–36.

Sheffi, Y., Rice Jr., J.B. (2005). A supply chain view of the resilient enterprise. *MIT Sloan Management Review*, *47*(1): 41–48+94.

Somers, S. (2009). Measuring resilience potential: An adaptive strategy for organizational crisis planning. *Journal of Contingencies and Crisis Management*, *17*(1): 12–23. https://doi.org/10.1111/j.1468-5973.2009.00558.x

Starr, R., Newfrock, J., Delurey, M. (2003). Enterprise Resilience: Managing Risk in the Networked Economy. *Strategy and Business*, *30*: 70–79.

Tillement, S., Cholez, C., Reverdy, T. (2009). Assessing organizational resilience: an interactionist approach. *Management*, *12*(4): 230–264. https://doi.org/10.3917/mana.124.0230

US Department of Homeland Security, Resilience. Available at: https://www.dhs.gov/topic/resilience [Accessed July 12, 2017].

Whitman, Z.R. *et al.* (2013). Short-form version of the Benchmark Resilience Tool (BRT-53). *Measuring Business Excellence*, *17*(3): 3–14. https://doi.org/10.1108/MBE-05-2012-0030

 