Conceptualizing and Measuring Resilience: Towards an Inter-disciplinary Versatile Model

Satoru Mikami

Abstract

Resilience is a buzzword in many disciplines, but it is plagued by conceptual confusion and little practical use. The purpose of this paper is to make resilience more analytically useful. Following a review of pre-existing definitions and operationalizations, this paper proposes a versatile framework that defines a resilience level as the consequence of intercepts and reversals of negative causal effects emanating from a triggering event on an entity's internal mechanisms and performance. A two-step inference method for potential resilience level using a recursive partitioning is also proposed as an alternative to the current indirect measure based only on expectations.

1. Introduction

Resilience is a highly popular recent buzzword across many fields. Individuals, households, organizations, communities, ecosystems, and institutions are all applauded if they show resilience, and they are encouraged to build it if they do not (Bahadur and Tanner 2014, Bryan et al. 2020, Davis 2009, Imilan et al. 2015, Leong et al. 2007, Ohto et al. 2017, Romain and Odom 2019, Sleijpen et al. 2017, Tracy et al. 2017). The backdrop of this growing demand for resilience is that crisis prevention and resolution, which have been the two most orthodox strategies, can no longer in themselves adequately deal with the recent crises that happen simultaneously and interconnectedly with increasingly unprecedented scope. Extreme weather and ecosystem disturbances caused by climate change (Haque et al. 2014), coordinated or often spontaneous attacks by terrorist networks armed with ICT (Harris 2017), abrupt and unpredictable changes in rapidly expanded but highly fragile global financial markets (Griffith-Jones and Tanner 2016), cross-border surge of migrants and refugees fleeing conflict and poverty (Mabiso et al.

2014), and outbreaks of unknown and frequently mutating infectious viruses like the COVID-19 can happen to anyone, anywhere. In other words, vulnerability to the recent crises is common to all and ubiquitous. Given these circumstances, contingent responses - in case prevention fails and resolution remains elusive - are something all entities must undertake regardless of the current status, if they are to continue to exist.

As is often the case with emerging buzzwords, however, the term 'resilience' tends to be used without any conscious denotation. Consequently, there is a danger that it could be treated as a mere opposite of 'vulnerability' despite the fact that resilient people can still be vulnerable (Béné et al., 2012) and that non-vulnerable (i.e., wealthy) people can be extremely non-resilient because of their heavy dependence on convenient but fragile devices. Furthermore, despite the almost unanimous agreement on resilience's necessity, the term's connotations remain ambiguous. For instance, what is the benefit of being resilient other than the direct consequence of being able to survive a crisis? What should be done to increase resilience? Is there any novelty that can differentiate resilience from the existing 'how-to' arguments regarding 'sustainability' or 'empowerment'? Is it simply old wine in a new bottle?

To clarify these ambiguities and make the concept more analytically useful, this paper tries to re-define resilience and proposes a versatile framework for empirical study. The structure of this paper is as follows. Section 2 reviews the pre-existing conceptualizations of resilience in as diverse disciplines as possible and classifies them into two camps: those from the perspective of an actor under threat and those from the perspective of a system composed of these actors. Section 3 combines essential elements from these two perspectives and constructs a causal chain in which resilience can manifest itself. After showing the way to rank the level of resilience based on possible causal patterns, Section 4 proposes a two-step method for estimating potential resilience. Section 5 concludes.

2. Literature Review

One of the reasons that make the concept 'resilience' confusing is the fact that there have been at least two different approaches to its conceptualization depending on the perspectives taken by researchers: one such perspective comes from that of an actor (individual, household, organization, etc.) who suffers from an adverse event and the other is from the perspective of a system (community, institution, society, etc.) composed of actors. The former deals with individual resilience, while the latter's focus is collective resilience. This divergence leads each approach to establish different reference points for defining resilience; namely, pre-crisis performance level and pre-crisis system composition domain.

2.1. Resilience from the actor perspective

The first type of conceptualization of resilience focuses on the level of performance of an actor affected by an adverse event. Typically, the trajectory of the level of performance after a shock is depicted with a line chart like in Figure 1[1]. Carver（1998）distinguishes four possible consequences: 1）*succumbing*, where the blow was too heavy for the actor to continue functioning; 2）*surviving*, where the actor keeps functioning but barely and at a lower level of performance; 3）*recovering*, where the actor succeeds in regaining the pre-shock level of performance; and 4）*thriving*, where the actor, after a downturn, outperforms the previous level. There is some disagreement as to whether the meaning of resilience should be limited to *recovering*（Carver 1998, Smith et al. 2008, FAO 2016）, but scholars who conceptualize resilience from the perspective of an individual actor under a disruptive event commonly use the pre-shock level of performance as a reference point.

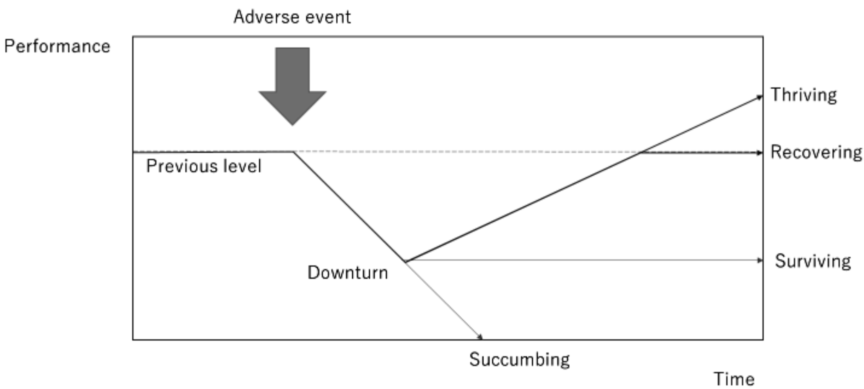

Figure 1 Typical graphic representation of resilience from actor's perspective

It should be noted that the previous level of performance, in contrast to the domain of system composition discussed later, does not necessarily have an attracting force. Of course, if the performance of concern is something for which biological homeostasis is expected such as body temperature or blood sugar level, the previous level of performance is the only value the entity can achieve if it is to exist. Neither *thriving* nor *surviving* is possible in the long run.

1）Carver 1998, p. 246; Rocco et al. 2018, p. 617.

However, in other contexts where the outcome of concern has no fixed point or range of possible value such as income, calory intake, sales, population, or GDP, the previous level is no more than a baseline value before the onset of the adverse event. As the possibility for *thriving* and *surviving* implies, post-shock performance can take any value.

In either case, as a corollary to the focus on the level of performance in conceptualizing resilience, resilience in this approach can be measured, at least theoretically, based on the trajectory of performance after the triggering event's inception. Rocco et al. (2018), for instance, propose two measures of resilience based on the baseline, midline (the lowest level of performance recorded after the shock) and endline performance level. One is the ratio of recovery to loss, i.e., the difference between the endline and the midline divided by the difference between the baseline and midline. Another is the time required for the full or certain degree of recovery. If time-series data is available for the performance of concern, it would be possible to judge whether an actor is resilient or not based on its trend. If the trend is descending, the actor is not resilient; if it is ascending or flat, the actor is resilient. Apparently, however, these measurements depend on the timing and duration of observation. An actor showing descending performance at the time of observation may start recovering a few units of time later.

Due probably to this inherent difficulty in judgment timing, researchers who conceptualize resilience focusing on the level of performance tend to avoid, after all, directly measuring resilience based on the performance result. Instead, they tend to use as a measure of resilience the number of factors thought to protect the actor from succumbing to a shock. Although the factors vary depending on the type of actor, the threat it faces, and the performance it seeks to defend, they can be grouped into two broad categories: the attributes of the actor and environmental factors. For instance, in studying a person's resilience to stressors in daily life to maintain emotional tranquility, Connor & Davidson (2003) use 25 items, which are summarized as personal competence and perception such as trust in one's instincts, tolerance of adverse effect, strengthening effects of stress, positive acceptance of change, sense of control, and spiritual influence and the environmental factors such as secure relationships. Likewise, Friborg et al. (2003) develop a scale composed of 37 items which include individual attributes such as personal competence, personal structure, and social competence as well as environmental factors like family coherence and social support. Smith et al. (2008), on the other hand, rely exclusively on individual attributes in constructing the brief resilience scale. In the context of the study on the household's resilience to natural and human disaster in securing sufficient daily nutrition and calory intake, FAO (2016) uses data on observable household's attributes such as assets and adaptive capacity and environmental factors such as access to basic services and social safety nets in constructing a resilience score as a latent variable. Also at the organization level, where resilience is primarily meant to overcome incidents such as industrial accident, natural disaster, and terrorism, while continuing business as usual, both corporate attributes such as resource slack, information sharing, corporate leadership, and preparedness for emergency (data back-up and business continuity planning) and environmental factors such as insurances and infrastructures including flexible and redundant supply chains are considered conducive to organizational resilience (Craighead et al. 2007, Linnenluecke 2017, Pettit et al. 2010, Wedawatta and Ingirige 2012) and used in quantifying the level of organization resilience (Lee et al. 2013).

2.2. Resilience from the system perspective

By contrast, the definition of resilience from the viewpoint of a system focuses not on performance but rather the composition and pattern of interactions among the actors constituting the system. All systems are believed to have an ability to self-reorganize after experiencing changes to the composition and pattern of interactions among its components, and the term "resilience" is used to describe the varying degree of this ability. Ratner et al. (2013), for instance, define the resilience of institutional arrangement that governs the use of common resources as its ability to prevent usual conflict over resources from escalating its intensity and extending in geographical scale and to other issues.

The ability to keep and, if disrupted, restore system integrity is not, however, static. Especially in ecology, a system's composition is expected to undergo an adaptive cycle composed of four phases: *rapid growth, conservation, release*, and *reorganization*. Therefore, a system's composition is typically described as a moving dot within a domain on a two-dimensional conceptual space. The boundary of the domain indicates the threshold, beyond which the system loses its ability to restore the original state. In other words, the width of the domain represents the maximum amount of change the system can tolerate. Carpenter et al. (2001) further decompose the notion of resilience into *resistance* and *persistence*. The former is the counterforce against the internal and external pressures that cause changes in the composition of or the pattern of interaction in the system while the latter refers to the ability of the system to absorb these changes. To capture the dimension of resistance, a third axis is introduced in the conceptual space and a *domain* now becomes a *basin* (Figure 2)[2].

2) Folke et al. 2004, p. 568; Gunderson 2000, p. 427; Holling 1973, p. 20; Walker et al., 2004.

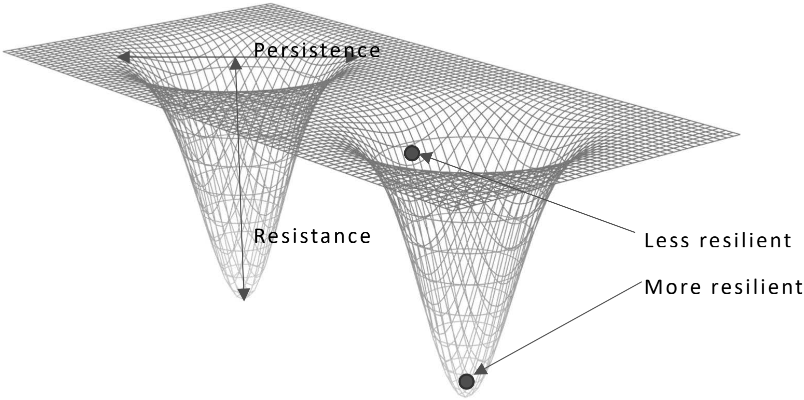

Figure 2 Typical graphic representation of resilience from system's perspective

The resilience of a system varies depending on its temporal location within the basin. A system at the edge is less resilient than one at the bottom of the basin. In ecology, the least resilient moment is believed to occur during the *release* phase of the adaptive cycle. The subsequent *reorganization* phase can result in a transition to a different new domain or renewal within the same old domain (Holling 1973, Gunderson 2000, Folke et al. 2004, Walker et al. 2004, Nkhata et al. 2008). To remain within the *basin* of origin is not necessarily desirable. This is because the desirability of any *basin* can differ from actor to actor who constitutes the system. This is another chief difference from the actor-centered conceptualization of resilience, which always regards non-resilience as a lesser state.

Meanwhile, what these two approaches share is the difficulty in quantifying resilience (Carpenter et al. 2001, Allen et al. 2005). Obviously, it is impossible to measure empirically the Euclidean distance between a coordinate of the system and the nearest edge of the basin on a conceptual space. Therefore, resilience per the system perspective is also measured indirectly using observable proxies. Carpenter et al. (2001), for instance, use indicators that are, in theory, inversely related to the resilience of concern (e.g. soil Phosphorus in the case of a clear-water state in a lake) while Angeler et al. (2018) propose using redundancy and the response diversity of entities who possess the same functional traits in the system on the ground that they are observable and expected to enhance the system resilience. Finally, Ratner et al. (2013), based on the theory of the institutional analysis and development, imply that the level of resilience can be estimated based on contextual factors such as the attributes of resources, attributes of resource users, and overall governance arrangement.

3. Reconceptualizing Resilience

The above review has revealed that the difference in the perspective tends to result in the difference in the focus in conceptualizing resilience. This is probably because when analyzing individuals, households, or organizations, the performance is the first and foremost matter of concern while the composition of, or patterns of interaction among the components of these actors are simply instruments to achieve better performance. Although performance usually depends on the components or patterns of interaction, the changes in themselves do not matter if the desired level of performance is maintained. By contrast, when analyzing ecosystems or institutions, composition or patterns of interaction in themselves matter most while the resulting performance is important in that it feeds back to the composition and the patterns of interaction in the next round.

Each emphasis is understandable and can be analytically efficient. To avoid confusion, however, it must be recognized that both internal mechanisms (composition or pattern of interaction) and performance can be affected directly or indirectly by a negative force regardless of the unit of analysis. That is, the framework to analyze resilience needs to have at least three components: a trigger, internal mechanism, and performance.

Examples of triggers that can start the process include stressors such as defeat in international war, invasion and occupation by foreign armed forces, insurrection, riots, demonstrations, terrorist attacks, an influx of migrants or refugees, drought, locust plagues, natural disasters, an outbreak of an infectious disease, industrial accidents, overconsumption, excess emissions, political or economic system breakdowns, over-workloads, and harassment. These triggers are, especially when they are exogenous to the actors and systems, extremely difficult, or impossible for the affected to control.

Examples of internal mechanisms and their components that are directly disrupted by triggers include social customs, explicit and implicit institutions, political and economic systems, corporate governance, human relations, family relations, livelihood (residence, income sources), soil fertility, forest coverage, natural resource availability, access to basic public services, infrastructure, supply chains, stock value, currency value, credit systems, individual physical condition, and phycological balance. As pre-existing studies point out, the internal mechanism as a dynamic is constantly fluctuating. As such, disruption of this internal mechanism is registered only if it transforms into a fundamentally different regime, which includes the change of units like dissolution and unification.

Finally, examples of the performance of actors and systems that can be directly or indirectly driven down by trigger include economic growth and the development of a country, eradication of poverty and corruption from society, public order and societal safety, business output and profit, harvest conditions, household income and food security, and individual physical, psychological, and material well-being. The difficulty in measuring performance is the timing of judgment, for the point below which performance will no longer recover is next to impossible to determine. Consequently, there is always a possibility that the declining performance of an actor or system will recover just after the observation terminates. Given this, the only solution to the problem is to limit the scope of time: Not recovering to the baseline level by a determined time limit means the reduction of the performance. Then, observing the unit of analysis twice before and after the trigger would suffice to determine the recovery of the performance and any disruption of the internal mechanism.

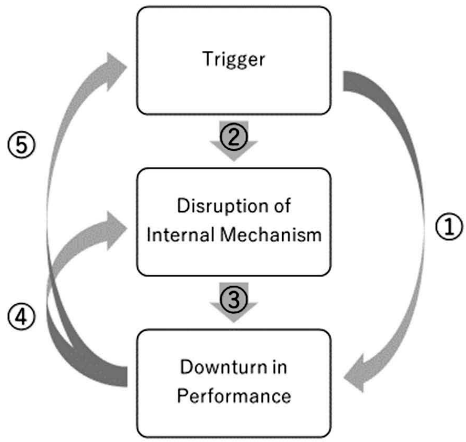

Figure 3 Direct and indirect adverse causal relations and vicious cycles

The causal chains among these three components can take various patterns. Figure 3 shows five causal relations. First, the effect of a trigger can be transmitted to the performance of the actor or system directly, or indirectly through the disruption of internal mechanism (Arrows 1, 2, and 3). For instance, at the individual level, overwork (a trigger) may cause an autonomic nervous system breakdown (a disruption of the internal mechanism), which in turn may reduce the person's productivity (a downturn in performance). However, overwork itself does not directly affect the worker's performance. At a country level, a defeat in international war (a trigger) can have both a direct adverse influence on the country's GDP (a downturn in performance) through the physical destruction of the country's main production sites as well as an indirect effect on GDP through the overthrow of the incumbent regime (a disruption of the internal mechanism). If, however, the internal mechanism is highly resilient (for instance, due to the monolithic nature of the political system), the trigger may not indirectly affect performance. In that case, the only causal relation is the direct effect of the trigger on the performance.

In addition to the influences of a trigger or disruption of the internal mechanism, reverse causality may occur (Arrows 4 and 5). A downturn in performance can either generate a new trigger, which delivers another blow to the internal mechanism and/or performance, or it can advance the disruption of the internal mechanism another step, which in turn leads to further performance downturn. For instance, a defeat in war (the first trigger) leads to the overthrow of the regime (the first disruption of the internal mechanism), which in turn deteriorates the performance of the state to deliver basic public service (a downturn in performance). This can induce widespread demonstrations and riots (the second new trigger), resulting in the breakdown of interim government (the second disruption of the internal mechanism), and the state may no longer offer any public services (the further downturn of the performance).

Resilience, then, should intercept and reverse each of the five causal effects: 1) from the trigger to the performance, 2) from the trigger to the internal mechanism, 3) from the internal mechanism to the performance, 4) from the performance to the internal mechanism, and 5) from the performance to the new trigger. Depending on which causal effects are intercepted and reversed, the possible scenarios once the trigger is pulled can be grouped into four:

A) The actor or system exposed to the triggering event succeeds in nullifying the adverse effect both to the performance and to the internal mechanism. No disturbance arises in the performance, nor in the internal mechanism.

B) The actor or system exposed to the triggering event succeeds in stemming the direct adverse effect on performance but fails to intercept the influence on the internal mechanism. In this case, if the actor or system continues to perform as usual despite the deficits in the internal mechanism, the damage will not reach the performance (B-1). If not, the trigger indirectly harms the performance. Nonetheless, the actor or the system can still prevent the reduced performance from deteriorating the internal system further and generating a new trigger. The actor or the system continues to exist but performs at lower rate than before and with deficits in the internal mechanism (B-2-1). If the actor or the system cannot stop the reverse negative effects from the lower level of performance, the vicious cycle sets in. The already disrupted internal mechanism undergoes another disruption, and a new trigger emerges that can additionally harm the internal system and/or the performance (B-2-2).

C) The actor or system exposed to the triggering event succeeds in stemming the adverse effect on the internal mechanism but fails to intercept the direct influence on the performance. In this case, if the actor or the system still prevents the reduced performance both from disrupting the internal system and generating a new trigger, the actor or the system with the same internal mechanism continues to exist with lower performance than before (C-1). By contrast, if it cannot stop either the reverse negative effect on the internal mechanism or the emergence of a new trigger, the internal system will also be damaged. If, however, the disrupted internal system does not have a negative effect on the performance, the vicious cycle remains partial (C-2-1). If it does have a negative effects, the vicious cycle intensifies (C-2-2).

D) The actor or system exposed to the triggering event fails to stem both the direct adverse effect on the performance and the direct influence on the internal mechanism. In this case, if it still prevents the reduced performance both from deteriorating the already disrupted internal system and generating a new trigger, it continues to exist with lower performance than before and with the disrupted internal mechanism (D-1). If it cannot stop either the reverse adverse effect to the internal mechanism or the emergence of a new trigger that can harm the internal system and/or the performance, the vicious cycle sets in. Whether the actor or system succeeds in preventing the disrupted internal system from affecting the performance decides whether the vicious cycle remains partial (D-2-1) or intensifies (D-2-2).

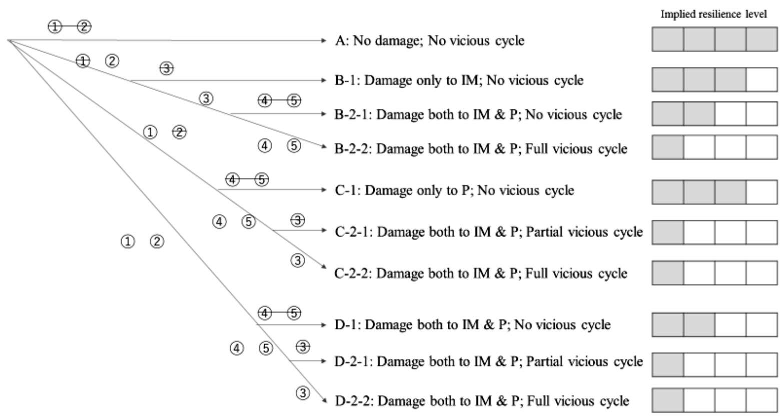

Figure 4 Possible scenarios once the problem arises

Note. IM: internal mechanism; P: performance. ①: trigger ➡ P; ②: trigger ➡ IM; ③: IM ➡ P; ④: P ➡ IM; ⑤: P ➡ new trigger. Strike-out line means that the causal effect is intercepted.

If the actor or system is resilient to the trigger, it should avoid falling into the vicious cycle because both partial and full vicious cycles have slim prospects for survival. In this sense, Patterns B-2-2, C-2-1, C-2-2, D-2-1, and D-2-2 are results that both actors and systems with low resilience will follow. By contrast, Pattern A is a scenario the most resilient actor or system will follow. Among the remaining patterns without vicious cycles, Patterns B-1 and C-1 can be considered as signs of a higher level of resilience than Patterns B-2-1 and D-1.

Having redefined resilience as above, it should be noted that resilience is a trigger-specific attribute. Depending on the trigger the entity or system faces, it can be resilient and non-resilient at the same time. Actors and systems can differ in terms of the number of triggers to which they are resilient, but given the infinite number of triggering events, the trigger in question must be specified when measuring resilience.

4. Measuring Resilience

The new definition of trigger-specific resilience as the consequence of interception and reversal of negative causal effects is neither the opposite of vulnerability nor the variant of sustainability or empowerment. This is a distinctive concept that describes what is called for and is not infrequently observed in recent years. The remaining task is to operationalize this definition.

The above discussion suggests a 4-point ordinal scale of trigger-specific resilience based on the actual trajectories the actors or systems follow once they are exposed to the triggering event. Such a result-based approach marks a break from the current dominant empirical strategies. As pointed out in the literature review, when resilience is conceptualized as a basin of system composition, observable proxies expected to enhance system resilience are used because it is impossible to measure the Euclidian distance in the three-dimensional conceptual space. When resilience is conceptualized as the recovery of performance to its baseline level, scholars tend to infer the level of resilience based on the checklist of attributes theoretically considered to be conducive to resilience, despite the fact that measurement based on performance trajectory is not necessarily impossible. Compared to the measurement based on the theoretical antecedents yet to be empirically proven, the empirical strategy based on the actual result is definitely more reliable. However, this approach only allows resilience to be measured ex-post facto. The resilience of entities and systems that have yet to encounter a triggering event remains unknown.

To overcome this deficit, one could create a triggering event artificially to expose the actors and systems to its effects. This would allow the expected level of resilience to be obtained before the occurrence of a real trigger. However, such an experiment is against research ethics and therefore infeasible. Therefore, the potential level of resilience of actors and systems that have not experienced a situation where resilience is required must be inferred using information obtained from the cases already exposed to a triggering event.

The inference this paper proposes consists of two steps. First, recursive partitioning is performed using the results and attributes of cases already exposed to a triggering event[3]. After the construction of the best model that can classify the results, this model is applied to cases that have not yet encountered a trigger. The obtained predicted results are the level of potential resilience.

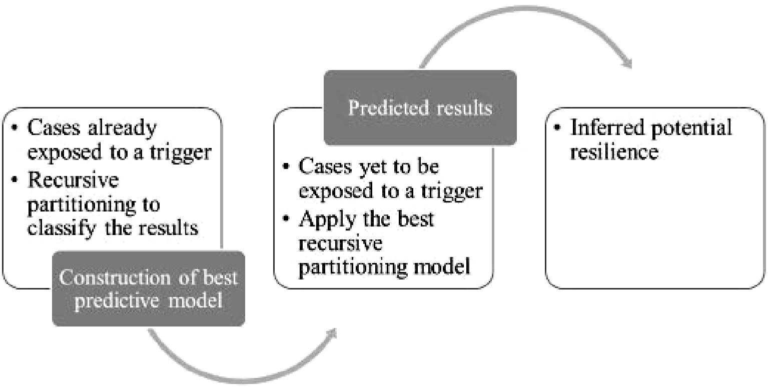

Figure 5 Flow of the two-step resilience measurement

This two-step estimation also uses theoretical antecedents of resilience. However, it differs from the previous approach in its method of extracting information. While previous approaches use all antecedents without evidence, this approach selects variables that have been empirically proven to be relevant at the first step of procedures. This means that, although the obtained potential resilience is not an actual value, it is based on the constantly updated evidence and the accuracy of measurement can be expected to further improve as the model accumulates experiences. Only after obtaining the separate measure of resilience, can factors that enhance or reduce resilience be explored in any rigorous way. Before that, any recommendations of resilience-building sound futile.

3) Recursive partitioning is preferable to regression because the partial coefficients obtained from multiple regression are likely to be biased due to omitted variables.

5. Conclusion

Despite almost unanimous agreement on the necessity of resilience, the term's meaning has remained ambiguous. Against this backdrop, this paper reviewed the existing conceptualizations and operationalizations of resilience in various disciplines, including psychology, development studies, business, ecology, and economics, and determined that much of the blame for this confusion stems from the existence of the different foci when arguing resilience: resilience of the internal mechanism or resilience of the performance. The difference tends to stem from the perspective the researchers take when they conceptualize resilience. If they conceptualize the resilience of an actor, they tend to focus on how its performance can be maintained. If they conceptualize the resilience of a system composed of actors, they tend to focus on how its internal mechanism can be preserved. Both actors and systems have their internal mechanisms through which they function as well as the various kinds of performance they produce as a result of their activities. Thus, both are legitimate endpoints in considering resilience. Therefore, this paper proposed a versatile framework that integrates both elements.

By clarifying possible adverse causal effects emanating from a triggering event as well as the consequences when these negative causalities are intercepted and reversed, this framework identified a set of scenarios that can serve as an indicator of different levels of trigger-specific resilience of an entity (an actor or a system). This result-based measurement of trigger-specific resilience can be applied not only to the entities that have already experienced a situation requiring resilience but also to those that have yet to encounter the triggering event. The key is the construction of recursive partitioning model based on the experiences of entities that have already undergone crises. The model extrapolation to those that have yet to encounter the triggering event enables the prediction of the scenario they will follow, which indicates the potential level of resilience of these entities to the triggering event. This two-step inference method, where only empirically proven relevant information is exploited, is more reliable than the existing empirical strategies, which rely solely on the theoretical antecedents. Continued feeding of the model with the experiences of various levels of unit and of the various triggers should improve the measurement both in terms of precision and applicability, and accumulated data on resilience should enable researchers and practitioners to develop an even more useful strategy of resilience building.

References

Allen, Craig R., L. Gunderson, and A. R. Johnson (2005). The Use of Discontinuities and Functional Groups to Assess Relative Resilience in Complex Systems. *Ecosystems*, 8: 958–966.

Angeler, David G., Craig R. Allen, Ahjond Garmestani, Kevin L. Pope, Dirac Twidwell, and Mirco Bundschuh (2018). Resilience in Environmental Risk and Impact Assessment: Concepts and Measurement. *Bulletin of Environmental Contamination and Toxicology*, 101: 543–548.

Bahadur, Aditya and Thomas Tanner (2012). Transformational resilience thinking: putting people, power and politics at the heart of urban climate resilience. *Environment & Urbanization*, 26 (1): 200–214.

Béné, Christophe, Rachel Godfrey Wood, Andrew Newsham and Mark Davies (2012). Resilience: New Utopia or New Tyranny? Reflection about the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes. *IDS Working Paper*, 405, Institute of Development Studies.

Bryan, Julia, Joseph M. Williams, and Dana Griffin (2020). Fostering Educational Resilience and Opportunities in Urban Schools Through Equity-Focused School-Family-Community Partnerships. *Professional School Counseling* 23 (1 part 2): 1–14.

Carpenter, Steve, Brian Walker, J. Marty Anderies, and Nick Abel (2001). From Metaphor to Measurement: Resilience of What to What? *Ecosystems*, 4: 765–781.

Carver, Charles S. (1998). Resilience and Thriving: Issues, Models, and Linkages. *Journal of Social Issues*, 54 (2): 245–266.

Craighead, C.W., Blackhurst, J., Rungtusanatham, M.J. and Handfield, R.B. (2007), The Severity of Supply Chain Disruptions: Design Characteristics and Mitigation Capabilities. *Decision Sciences*, 38: 131–156. doi:10.1111/j.1540-5915.2007.00151.x

Davis, Mary C. (2009). Building Emotional Resilience to Promote Health. *American Journal of Lifestyle Medicine*, 3 (1): 60–63.

FAO (2016). *RIMA-II: Resilience Index Measurement and Analysis – II*. Food and Agriculture Organization of the United Nations, Rome.

Folke, C., Carpenter, S., Walker, B., Scheffer, M., Elmqvist, T., Gunderson, L., and Holling, C.S. (2004). Regime Shifts, Resilience, and Biodiversity in Ecosystem Management. *Annu. Rev. Ecol. Evol. Syst*. 35: 557–81.

Friborg, O., Hjemdal, O., Rosenvinge, J.H., and Martinussen, M. (2003). A new rating scale for adult resilience: what are the central protective resources behind healthy adjustment? *International Journal of Methods in Psychiatric Research*, 12(2): 65–76.

Griffith-Jones, S., and Tanner, T.M. (2016). Financial Crises and Economic Resilience: Lessons for Disaster Risk Management and Resilience Dividends. In Surminski, S. and Tanner, T.M. (Eds.) *Realising the Triple Resilience Dividend: A New Business Case for Disaster Risk Management*. Springer International Publishing, Dordrecht, 151–172.

Gunderson, Lance H. (2000). Ecological Resilience – In Theory and Application. *Annual Review of Ecology, Evolution, and Systematics*, 31: 425–439.

Haque, Anika Nasra, David Dodman, and Mohataz Hossain (2014). Individual, communal and institutional responses to climate change by low-income households in Khulna, Bangladesh. *International Institute for Environment and Development* 26 (1): 112–129.

Harris, Lord Toby (2017). London and anti-terrorism in Europe. *European View*, 16: 261–269.

Holling, C. S. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology, Evolution, and Systematics*, 4: 1–23.

Imilan, Walter A., Xenia Fuster and Paulina Vergara (2015). Post-disaster reconstruction without citizens and their social capital in Llico, Chile. *Environment & Urbanization*, 27 (1): 317–326.

Lee, Amy V., John Vargo, and Erica Seville (2017). Developing a Tool to Measure and Compare Organizations' Resilience. *Nat. Hazards Rev*. 14:29–41.

Leong, Kare J., Christopher A. Airriess, Wei Li, Angela Chia-Chen Chen, and Verna M. Keith (2007). Resilient History and the Rebuilding of a Community: The Vietnamese American Community in New Orleans East. *The Journal of American History*, 94(3), 770–779.

Linnenluecke, Martina K. (2017). Resilience in Business and Management Research: A Review of Influential Publications and a Research Agenda. *International Journal of Management Reviews*, 19: 4–30.

Mabiso, Athur, Jean-François Maystadt, Joachim Vandercasteelen, and Kalle Hirvonen (2014). Resilience for Food Security in Refugee-hosting Communities. In Shenggen Fan, Rajul Pandya-Lorch, and Sivan Yosef (Eds.) *Resilience for Food and Nutrition Security*. International Food Policy Research Institute, 45–52.

Nkhata, Abraham B., Charles M. Breen, and Wayne A. Freimund (2008). Resilient Social Relationships and Collaboration in the Management of Social-Ecological Systems. *Ecology and Society*, 13(1):2.

Ohto, Hitoshi, Seiji Yasumura, Masaharu Maeda, Hiroshi Kainuma, Keiya Fujimori, and Kenneth E. Nollet (2017). From Devastation to Recovery and Revival in the Aftermath of Fukushima's Nuclear Power Plants Accident. *Asia Pacific Journal of Public Health* 29 (2): 10–17.

Pettit, T.J., Fiksel, J. and Croxton, K.L. (2010), Ensuring Supply Chain Resilience: Development of A Conceptual Framework. *Journal of Business Logistics*, 31: 1–21. doi:10.1002/j.2158–1592.2010.tb00125.x

Ratner, Blake D., Ruth Meinzen-Dick, Candace May, and Eric HaglundRatner (2013). Resource conflict, collective action, and resilience: an analytical framework. *International Journal of the Commons*, 7 (1): 183–208.

Rocco, Claudio M., Kash Barker, Jose Moronta, and Jose E. Ramirez-Marquez (2018). Community detection and resilience in multi-source, multi-terminal networks. *Journal of Risk and Reliability*, 243(6): 616–626.

Romain, Amy M., and Amy J. Odom (2019). Collaborative work partnerships: Fuel for personal resilience. *The International Journal of Psychiatry in Medicine* 54(4–5): 259–265.

Sleijpen, Marieke, Trudy Mooren, Rolf J. Kleber, and Hennie R Boeije (2017). Lives on hold: A qualitative study of young refugees' resilience strategies. *Childhood*, 24 (3): 348–365.

Smith, Bruce W., Jeanne Dalen, Kathryn Wiggins, Erin Tooley, Paulette Christopher, and Jennifer Bernard (2008). The Brief Resilience Scale: Assessing the Ability to Bounce Back. *International Journal of Behavioral Medicine*, 15: 194–200.

Tracey, Shannon, Tracey L. O'Sullivan, Daniel E. Lane, Emily Guy, and Jill Courtemanche (2017). Promoting Resilience Using an Asset-Based Approach to Business Continuity Planning. *SAGE Open* April-June 2017: 1–15.

Walker, B., Holling, C. S., Carpenter, S. R., and Kinzig, A.(2004). Resilience, Adaptability and Transformability in Social–ecological Systems. *Ecology and Society* 9(2): 5.

Wedawatta, G. and Ingirige, B. (2012). Resilience and adaptation of small and medium-sized enterprises to flood risk. *Disaster Prevention and Management*, 21(4): 474–488. https://doi.org/10.1108/09653561211256170

Williams, Amanda, Gail Whiteman, and Steve Kennedy (2019). Cross-Scale Systemic Resilience: Implications for Organization Studies. *Business & Society,* 60(1): 95-124. https://doi.org/10.1177/0007650319825870