

The cover features a dark blue background with large, overlapping circular shapes in shades of blue. In the top left corner, there is a square inset image showing a blue-toned, futuristic scene with a central circular area filled with a starry, nebula-like pattern, surrounded by glowing lines and data-like elements.

Monographs in Risk and Resilience Volume 1

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Monographs in Risk and Resilience Volume 1: 2020

'Monographs in Risk and Resilience' is a new, open, independent and professional journal series that is published as an annual volume.

The majority of journal-style publications in the fields of risk and resilience provide a limited size with which to review a subject and explore new ideas. Monographs in Risk and Resilience provides a platform to explore current and emerging knowledge and develop a new understanding in a comprehensive and deep way.

Today there are many published articles that support and are supported by belief systems about risk and resilience that are unsupported by robust evidence. We encourage thinking and writing that is iconoclastic, that challenges old paradigms, and the accepted dogma.

The intent of 'Monographs' is not to present a one single truth, but rather to provide different sides of an argument, and to stimulate a critical review of those arguments. In doing so, sufficient information should be made available to allow readers to question, to investigate and to make informed decisions.

Above all else, the 'Monographs' publication serves to promote thinking that will engender change and improve the way that risk is managed and how resilience is approached. In particular, 'Monographs' promotes thinking that is supported by robust evidence.

Each Volume of 'Monographs' will publish between one to three substantial papers on a unified theme, with independent peer review. At this stage the intention is to publish 'Monographs' electronically, which will be available on the ARPI website www.arpi.org.au free of charge both to its members and to the public.

In this, the inaugural Volume of the 'Monographs,' I have written the single monograph that constitutes the publication which was subjected to independent peer review.

I would like to encourage ideas for the second Volume, to be published in 2021 (refer to the call for papers in this volume).

To facilitate the publication of 'Monographs' an interim Editorial Board has been established, which will be finalised over the next few months.

Dr Carl Gibson
Interim Editor in Chief
Victoria, Australia.

Australian Risk Policy Institute - Chairman's Foreword

I am pleased that ARPI is able to support Dr Gibson in publishing this independent series on risk and resilience to encourage greater, in-depth thinking. ARPI is busy right now applying its Strategic Risk Policy™ approach to develop new global modelling on resilience and this series contributes to public awareness and debate on moving to a new level of understanding.

As the Monographs in Risk and Resilience goes to press, COVID-19 continues to occupy everyone's thoughts. 'Surprises' to emerge from this pandemic include governments, organisations and practitioners that have been unprepared for such a crisis.

The inadequacy of so many 'traditional risk management', business continuity and resilience approaches is also of no surprise. Currency and relevance of such approaches have been apparent for several years. ARPI recognises that challenges to global resilience are changing almost daily, hence our assumptions, thinking and approaches need to be fluid and adaptive to address the growing capability gap.

Continuing to rely on failed, traditional, linear and rational risk management models is no longer an option, neither is the occasional tweaking at the edges of these models. A new global model requires 'convergence' of currently divergent approaches from multiple disciplines and a unique integration of different frames of thinking. Existing discipline-based silos, often based around a single outdated concept, need to be reinvigorated by new ideas and artificial concept boundaries between disciplines need to become seamless.

The Australian Risk Policy Institute as Convenor of the Global Risk Policy Network has been actively working towards addressing these problems and improve complex decision-making capability. The Monographs in Risk and Resilience is one approach to encourage challenging orthodoxy and help communicate and share new knowledge for a changing world – moving to a new normalcy.

I encourage you to not just read this publication but to join the growing world-wide discussions that are challenging accepted beliefs and driving new thinking.

Best regards

Tony Charge JQ FARPI CRPS
President



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Strategic Risk Policy™ (SRP)

SRP as developed by ARPI is an innovation in the world of risk as a concept and offers new thinking and approaches about risk as it relates to resilience, by considering the environment at an earlier stage and in a different manner. Rather than focusing on managing identified risks, SRP looks at protecting against 'potentiality' or 'possible' strategic risks – at the point of systems vulnerability.

SRP and resilience will be the subject of a number of different publications over the next few years that will build on this Monograph series, with the purpose of establishing a world class knowledge base, and challenging the misinformed commentary and confection.

In the meantime, information about SRP appears on ARPI's website at www.arpi.org.au

CALL FOR PAPERS

‘Monographs in Risk and Resilience’ is a new peer-reviewed independent series published by the Australian Risk Policy Institute to stimulate public debate. ‘Monographs’ provides the opportunity for authors to explore concepts and develop ideas to a level of detail that may other publications do not allow.

Papers are now being sought for Volume 2 to be published in August 2021.

The theme for Volume 2 is:

“The successes and failures of risk, business continuity and crisis management in a time of COVID”.

Volume 2 will publish a maximum of three papers, each with an expected size of between 50 to 100 pages (20,000 to 40,000 words).

This call for papers is an open call for initial expressions of interest.

Prospective authors should submit an initial expression of interest, comprising:

Proposed monograph (not more than 2 pages)

- A summary of issues to be addressed within the proposed theme.
- A summary of areas of existing knowledge to be covered and how these will be critically reviewed.
- Emerging or new concepts that will be developed.
- Industry sectors and types of reader that will be key audiences for the monograph.
- Outline of the overall conclusion that will be developed.

Author details

For all authors to be included on the monograph(2 page per author limit)

- Full name and titles for all intended authors.
- 5 most recent publications.
- Highest ranking publication achieved, or publication with the most profound impact.
- Summary of expertise and experience relating to the theme for Volume 2.
- Declaration of ability to meet the key milestones for submission.

Expressions of interest should be forwarded to:

education@arpi.org.au

No later than 30 September 2020

Indicative dates by 5.00pm Canberra time

30 September 2020:	submission of expression of interest
15 October 2020:	review of submission by Editorial Board and invitation to develop and submit a monograph
30 October 2020	signed author agreements.
15 December 2020:	Progress report by authors
28 February 2021:	Submission of review draft of monograph
30 April 2021	Completion of peer review
15 May	Editorial Board review
20 May	Feedback to authors
30 June	Finalised manuscripts submitted
20 July	Copy edits provided
30 July	Author confirmations
15 August	Online publication

Author Biography

Dr Carl A. Gibson

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Carl's early career saw service with the British Army and with the London Metropolitan Police. He subsequently entered medical research, and then led diagnostic and field investigations into infectious disease outbreaks in Australia. Carl has held senior appointments in government, in the international corporate sector and in the University sector. He has also led local, State and national responses to a range of disasters and crises, including infectious disease outbreaks, infrastructure failures, floods, bushfires, kidnappings and terrorist attacks.

Carl has co-authored a number of Australian, New Zealand, Singaporean, USA and ISO Standards and continues to be active in the development of risk, resilience, security, emergency and crisis management Standards.

He currently works as a researcher and consultant (for Executive Impact Consulting) in the areas of organisational strategy, risk, resilience and security, with a particular interest in the neuroscience of decision-making on complex problems and under high uncertainty.

Carl is Chair of the Australian Risk Policy Institute's Educational Committee and the Inaugural Chair of the Global Resilience Risk Policy Group.

Monograph: Perspectives on Resilience

Dr Carl A. Gibson

Introduction

For many individuals and organisations, traditional prevention, mitigation-based actions¹, and response-based approaches², are becoming less able to meet the demands of a continually changing world (Lavell et al, 2012). Most organisations now operate inside, or interact with sociotechnical systems³ so complex that they defy any meaningful understanding of their interdependencies and operation under changing conditions (Lechner et al, 2016). Hence, there is a strong continuing argument to move to anticipatory, adaptive, agile and integrated arrangements that can contribute to community and organisational resilience (Pollock, 2016). A substantial problem is that all of the decisions we need to make about resilience have to have a sense of the future, however, all of our experience and knowledge is about the past.

This thing called resilience

The popularity of the term resilience has increased dramatically over the last decade or so⁴, and although described in many different ways, has been commonly viewed as a search for survival and adaptation (Christopherson et al, 2010). Governments talk about various aspects of societal resilience, policy is developed, legislation enacted, and a continuing stream of initiatives are launched in the hope of enhancing community and critical infrastructure resilience. Within individual organisations, existing functions are combined and rebranded as 'Resilience Departments', whilst some standardisation bodies try to convince organisations to buy Standards that will 'build resilience' in one form or another.

A range of professional associations, consultants and other individuals promote 'resilience' as a strategy or set of plans to be implemented, structures and processes that can be designed and built, or as a technical certification that can be gained through attending a few days of training. There have even been entire organisations established to 'pursue' resilience, some with a genuine research

¹ Such as many common risk management approaches.

² Such as emergency management, business continuity, disaster recovery, etc.

³ Sociotechnical systems relate to the interactions of people, society (and its substructures), processes, information and knowledge (Richardson, 2016). It therefore encompasses most areas of human decision-making and activity. It is often applied to the overall system of people, technology and organisations operating within their wider physical, societal and economic environments (Belmonte et al, 2010). This is different to the more narrowly conceived socio-technical systems - STS which deals with human -technology interaction in the workplace (Applebaum, 1997), and more expansive than the cognitive system approach (Woods and Hollnagel, 2006; Hollnagel, 2002).

⁴ Although the original concepts about resilience date back at least to Aristotle in the 4th Century BC (Aristotle, 1955). Its more modern usage has its origins in engineering contexts during the industrial revolution (Merriman, 1885; Mallet, 1862) and even more recently in ecology (Holling, 1973). The popularity of the term expanded during the early 2000's when it became increasingly applied as a concept to organisations and communities (Reason, 2001; Carthey et al, 2001; Paton, et al, 2000; Reason, 2000). The use of 'resilience' entered the mainstream in 2003 (Hamel and Välikangas, 2003) and increased in popularity in the aftermath of the global financial crisis as many organisations sought to address the perceived failures of business continuity and risk management.

focus⁵, whilst some others operate as thinly disguised consultancies. Researchers continue to publish a plethora of papers on different aspects of resilience, and various pundits publish more and more management books claiming to deliver the great secrets of building resilience. Such publications are often based upon the experience of a single *lucky* organisation surviving some disaster where others faltered, their one-off experience being inappropriately extrapolated to fit all situations and all types of organisations.

Where organisations or individuals appear to fail in the face of any adversity, a lack of resilience is commonly cited as the reason, as though this really explains why something happened in the way that it did. Following which, the knee jerk reaction is to do something (often anything!) that conveys an impression of activity and building better ‘resilience’. In some jurisdictions, in the last few years, the emphasis on resilience has receded, accompanied by a resurgence of attention on preparedness (Kahan, 2015). However, such thinking often promotes preparedness as if it was somehow separate to, and not an important part of resilience.

Nevertheless, an increasingly high VUCA⁶ environment continues as an ever-present stressor to many organisations (Lechner et al, 2016), and resilience continues to attract considerable interest as the perceived silver bullet. This is despite a general absence of a deep understanding about what resilience actually is and entails for many organisations. Many of the attempts at both explaining and purposely building resilience have taken a reductionist and mechanistic approach, trying to establish resilience as a small set of isolated components that can be ‘bolted-on’ one-by-one, from a boilerplate menu.

Yet despite a couple of decades of activity, there still persist multiple interpretations and definitions of community and organisational resilience with respect to incidents, emergencies, disasters and disruptions. Each stakeholder promoting its own variation of resilience, depending upon its vested interests, although in some other disciplines (engineering, ecology etc.) more accepted concepts of resilience have been achieved, along with some level of definitional agreement. We are also seeing a number of ‘salesmen’ taking different combinations of old resilience principles and models and repackaging them as some new great alternate resilience system or consulting offering⁷.

With the diversity of descriptions, definitions and opinions regarding resilience, it is no surprise that the concept is applied in different ways to suit the agenda of the proponent and the perceived desires of the audience. Resilience, in this respect, may be following a similar path to that undertaken with sustainability (Stumpp, 2013).

Perhaps the whole ‘field’ of resilience can be simply summed up by:

“Resilience is a family of related ideas, not a single thing. The various situations that we have sketched offer different levels of challenge, and may well be met by different organisational mechanisms” (Westrum, 2006).

⁵ For example: Torrance Resilience Institute (Adelaide, South Australia); Community and Resilience Institute (Washington, DC); The Resiliency Centre (Portland, Oregon); Institute for Resilient Communities (Lawrence Berkeley National Laboratory, California); Institute of Hazard, Risk and Resilience (Durham University, UK); Stockholm Resilience Centre.

⁶ VUCA: is a way of describing the challenging environment that many of us now face: high volatility, high uncertainty, high complexity, and high ambiguity. Alternate models exist such as TUNA (turbulence, uncertainty, novelty, ambiguity) Ramírez and Wilkinson, 2016. Both of these acronyms are ultimately dealing with different aspects of uncertainty, however, they provide only a limited perspective on the range and different types of uncertainty that should be considered with respect to resilience.

⁷ Herein lies a significant danger, where ‘resilience’ has failed in the past it is because what was put in place was some confected idea that ignored the complexity of real world organisational need and operability. Boilerplate solutions rarely work across different organisations despite any fancy language or marketing hype. The failures of the past will almost certainly be repeated the any of today’s promises of a silver bullet. We have yet to see anything that is truly innovative and evidence based in the arena of resilience building.

As this “family of ideas” tries to address disruption, it is also worth remembering that resilience is not just about being prepared for a single (devastating) event, but is about being ready for a wide range of different conditions that may be faced in the future (Kendra and Wachtendorf, 2003, either singly or simultaneously). It is also important to remember that each individual, group, or part of an organisation or community may each be affected differently by a potential or actual disruption.

Some of the thinking on resilience has certainly been hijacked by the likes of parts of the traditional business continuity community, pervading resilience with an unfortunate focus on just fixing the *effects* of disruptive events. This has resulted in a lack of thinking about tackling the problems which generate disruption in the first place, as well as a common disregard of the human elements that are essential to infrastructure⁸ and processes. Some commentators have even suggested that preventive, protective, and other proactive risk reduction measures sit outside of the concepts of resilience (we will not give further credibility to this nonsense by identifying sources).

Any serious thinking about resilience needs to consider reducing the existence of and exposure to disruptive conditions, lowering uncertainty, and addressing vulnerability, as well as dealing with the consequences of disruption. An organisation that does little to protect themselves from disruptive conditions, will forever be faced with the need to respond to and recover from actual disruption.

It has been proposed that there are three possible postures that can be adopted to a threatened or actual disturbance (Handmer and Dovers, 2009):

- “*Resistance and maintenance*”, where effort is put into avoiding any change in the system. For some this may even involve individual and institutional denial that there is any demand or pressure to change.
- “*Change at the margins*”, where the demand, pressure, and the need to change is recognised, resulting in small progressive adjustments and modifications being made.
- “*Openness and adaptability*”, where the challenge is recognised and accepted. Flexibility and adaptability are built in from preparedness activities, and assumptions are tested and modified or replaced where necessary.

The nature of resilience

Depending upon the context, many of the different definitions and described attributes that have been applied to resilience may be valid, and it could be that any capability that helps a system to ‘degrade gracefully’ (Pellisier, 2011; Allenby and Fink, 2005) is contributing towards resilience. The challenge, however, is to explore the ideas of resilience and extract the most meaningful concepts that can be used to improve an individual’s, group’s, organisation’s or community’s ability to manage disruption, *in their own unique context*.

Whatever we decide is the ‘composition’ of resilience, it will always be, in one way or another, the means by which societal and organisational fragility is addressed. Ideally this will be achieved by focussing more on strengths that can further be developed, rather than just addressing weaknesses that need to be corrected.

⁸ Many business continuity plans pay almost exclusive attention to resources: infrastructure and processes, and often include information and roles of key personnel, but almost all disregard the effects of non-routine environments on human sensemaking, decision-making, behaviours, coping mechanisms and interrelationships, all of which are essential contributors to organisational resilience.

The context for disruption

The starting point for understanding resilience is to answer the question “*resilient to what?*”. In any socio-technical system, such as an organisation, resilience must be defined in terms of the underlying conditions that could give rise to a disruption or existential threat.

The nature of disruption

A disruption is any event, or change in circumstance that has an intolerable effect on a system’s⁹ purpose and objectives. Disruption can arise as a result of change within the environment a system operates within, within the system itself, or as a result of change in the nature of the interaction between the system and its external environment.

Change, both in the external and internal environments, can act as a significant stressor to the system, and be a source of emerging and potentially disruptive conditions (Figure 1). Change may also have asymmetric effects, a small change can result in disproportionately large disruptive effects, and vice versa. Disruption can arise from any type of change, including:

- Unforeseen change: which is unexpected and is often undetected until harmful effects are being felt.
- Unintentional change: that the organisation is aware of but is incapable of, or unwilling to tackle effectively.
- Planned or intentional change: which has unforeseen and unwarranted outcomes.

Change that is perceived as positive, such as pursuing an emerging opportunity, can be a source of significant disruption to routine operations. For example, the collapse of an airline company can be a boon for its competitors, but the need to deal with enquiries from and find seats for thousands of ‘new’ customers whose flights have been cancelled can be a major source of disruption for those other airlines. Conversely, disruption can also be a source of opportunity for an organisation that is resilient, driving innovation and new and improved ways of working (Ates and Bitici, 2011). Disruption therefore arises as a result of change in a system’s context.

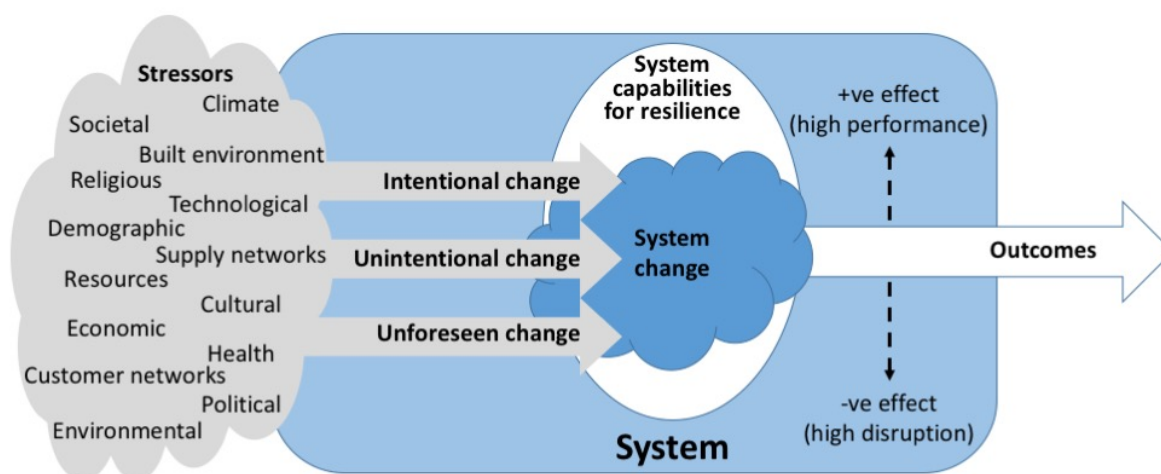


Figure 1: Stressors and change

⁹ In this context a system is any definable entity, which may be an organisation, community, or other organised grouping. A system may also encompass interrelated constituent parts of a larger system.

From an organisation's perspective, context is continually evolving, presenting a varying landscape of disruptive threats, hazards and risk (Dongxia and Kan, 2011; Huczynski and Buchanan, 2007), with different types of disruptive events becoming apparent (Westrum, 2006), including:

- *Regular events*: which have been experienced by most people and are familiar, these include such situations as power outages, equipment failures, storm events, sexual harassment, bullying, etc.
- *Irregular events*: are uncommonly encountered but *appear* familiar (for example may have been previously 'experienced' indirectly through media coverage of an event). These types of event include situations such as a nuclear reactor failure, devastating earthquakes, large scale bushfires, mass casualty incidents, lone wolf terrorist attacks, corporate fraud, corruption, etc.
- *Unexampled events*: perceived to be extremely rare or previously unimagined such as the 9/11 attacks, sinking of the Titanic, etc. Unexampled events are often characterised by there being little prior experience, awareness, or understanding. The so called 'black swan' (Taleb, 2008) is a particular kind of unexampled event.

Such 'regular' and some 'irregular' events are often considered in traditional preparedness planning. However, historically, preparedness for many irregular events has been poor, whilst unexampled events have been largely ignored. Part of the rationale of 'all hazards' preparedness is to develop capability that can cope with any event, including unexampled events (Paton, 2015), without the need to specifically *anticipate all of the details* of their potential occurrence. However, there still remains a substantial role for other aspects of resilience, such as adaptive capacity, for dealing with these types of unexampled events, should they occur.

Exploring the context for disruption provides the basis for better understanding uncertainty and associated risk, which in turn should create a foundation for developing strong capabilities for improved resilience.

Definitions of resilience

Despite a couple of decades of interest in resilience, and the range of definitions that have been touted, the concept still remains 'fuzzy' in many quarters (Shaw and Maythorne, 2013) and is often used as a catch-all concept (Funfgeld and McEvoy, 2012). Resilience has been frequently described both in terms of a process by which a resilient state is achieved, or as an outcome – a state of being resilient (Kaplan, 1999). There continues to be considerable debate across many different constituencies, reflecting both different philosophical origins (e.g. resilience as a property, resilience as an input, resilience as a process, resilience as an output, resilience as an outcome, resilience as a state, etc.). The actual meaning of resilience changes depending upon the context in which it is applied (Joseph, 2013), and most frequently involves a dual focus on the search for both capability and vulnerability.

We often think of a 'level' of resilience in relation to achieving a minimal disruptive impact, or maintaining acceptable performance in the face of such a disruption. However, resilience may also be considered in terms of the time taken after a disruption for a system to regain that acceptable performance capability. Applying the concepts of resilience in different disciplines has generated a substantial range of definitions, also reflecting, to a certain extent, the prevailing philosophical perspectives in each of those domains. These domain definitions also reflect an evolution in thinking about resilience (Table 1 and Figure 2). The more mature the domain, the more likely that an agreed understanding of resilience has been achieved *for that domain*.

Table 1: Selected resilience definitions

Resilience domain	Definition	Reference
Systems resilience	“Resilience... the capacity of a system to absorb disturbance and re-organise so as to retain essentially the same function, structure and feedbacks – to have the same identity”.	(Walker, 2012)
	Resilience is described as a function of system vulnerability and adaptive capacity that gives rise to the continuing function of the system in the face of stress.	(Dalziell and McManus, 2004).
	“Resilience is a property of a complex system – it is the capacity to survive, adapt and grow in the face of change and uncertainty, particularly related to disturbances with a high impact and low probability” “Resilience is largely about learning how to change in order not to be changed”.	(Böggemann and Both, 2014). (Walker, 2012)
Ecological resilience	Resilience reflects the magnitude of disturbance that can be absorbed before a system changes its structure and behavior controls, and flips into a new state.	Holling, 1996).
Engineering resilience	“...concentrates on stability at a presumed steady-state, and stresses resistance to a disturbance and the speed of return to the equilibrium point”.	(Berkes and Folke, 1998; Holling, 1996).
People & psychological resilience	“...ability ... exposed to an isolated and potentially highly disruptive event ... to maintain relatively stable, healthy levels of psychological and physical functioning”.	Bonanno, 2004
	“The capacity of people to cope with stress and catastrophe, implying that some people succeed in the face of adversity and demonstrate the ability to withstand and rebound from disruptive life challenges”.	Lee et al, 2009
Social and community resilience	“The ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change”.	Adger, 2000
	“Resilience refers to the ability of a human system to respond and recover”.	Cutter et al, 2008a
	“Community resilience is a measure of the sustained ability of a community to utilize available resources to respond to, withstand, and recover from adverse situations”.	Rand, 2018
Humanitarian resilience	A multifaceted and multidimensional construct providing an ability to cope with “current and future shocks, stresses and uncertainty” and involves the capabilities for livelihood viability, innovation, contingency resources and support, social and institution access and adaptation, and the integrity of natural and build environments.	Oxfam, 2013
	“The ability of people, households, communities, countries, and systems to mitigate, adapt to, and recover from shocks and stresses in a manner that reduces chronic vulnerability and facilitates inclusive growth”.	USAID, 2015
Cultural resilience	“Reinforcing culture and traditions as a source that enables resistance against livelihood vulnerabilities” and involves cultural and spiritual values, customs and traditional knowledge.	Daskon, 2010
Supply chain resilience	“Resilience is an innate tendency, usually consisting of several inter-related parts, that allows a system to flex under stress and bounce-back to something similar to its pre-existing condition once the stress is lessened or removed”.	Palin, 2013
Critical infrastructure resilience	“Infrastructure resilience is the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event”.	NIAC, 2009
	The ability of assets, networks and systems to anticipate, absorb, adapt to and/or rapidly recover from a disruptive event.	Cabinet Office, 2011
	“The continued operation of critical infrastructure in the face of all hazards”.	Australian Government, 2015
Cyber resilience	“Cyber resilience refers to the ability to continuously deliver the intended outcome despite adverse cyber events”.	Björck, 2015
	“Ability of systems and organizations to withstand cyber events. Resilience in this context means the preparations that an organization has made with regard to threats and vulnerabilities, the defences that have been developed, and the resources available for mitigating a security failure after it happens”.	Dobrygowski, 2016
	“Ability to deliver, maintain, improve service when facing threats and evolutionary changes.	ReSIST, 2007

Resilience domain	Definition	Reference
Economic resilience	"Economic resilience...refers to the inherent and adaptive responses that enable individuals and communities to avoid some potential losses".	Rose, 2004
	"The ability of an economy or a society to minimize welfare losses for a disaster of a given magnitude".	Hallegatte, 2014
Financial resilience	"Resilience is a characterization of the way successful managers deal with the inevitable but unforeseen interactions, difficulties and opportunities that arise during the implementation and operation business activity".	FT, 2018
Disaster resilience	"The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions".	UN-ISDR, 2009
	"Resilience is the capacity of a social system (e.g., an organization, city, or society) to proactively adapt to and recover from disturbances that are perceived from within the system to fall outside the range of normal and expected disturbances".	Boin et al, 2010
	"The ability to prepare and plan for, absorb, recover from, and more successfully adapt to adverse events".	National Research Council, 2012
Urban resilience	"The capacity of a city to rebound from destruction".	Vale and Campanella, 2005
Socio-ecological resilience	"The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure and feedbacks, and therefore identity, that is, the capacity to change in order to maintain the same identity".	Folke et al, 2010
Organisational resilience"	"Capability to self-renew over time through innovation"	Reinmoller & van Baardwicjk, 2005
	"The characteristic of managing the organisation's activities to anticipate and circumvent threats to its existence and primary goals".	Hale & Heijer, 2006
	"Maintenance of positive adjustment under challenging conditions".	Vogus and Sutcliffe, 2007
	"Develop situation specific responses.....engage in transformative activities"	Lengnick-Hall et al, 2011
	"Organizational resilience is an ability to anticipate risks and future trends (prepare/before); to understand the situation, to resist, and act thoughtful (response/during); to recover fast, to adapt, and to renew or reinvent (recover/after) while effectively aligning operational with corporate strategies to be able to survive in turbulent and complex environments".	Hillman, 2013
	"Is the ability of an organisation to adapt to the requirements of the surrounding environment and being able to effectively develop new capabilities to absorb and manage environmental variability".	Jaarin and Backhouse, 2014.
	"The capacity of business to survive, successfully adapt and prosper in the face of change and uncertainty related to disturbances with a high impact and a low probability".	Bresch et al, 2014.
	"Incremental capacity of an organization to anticipate and adjust to the environment".	Ortiz-de-Mandojana & Bansal, 2015
	"Refers to the ability to respond productively to significant disruptive change and transform challenges into opportunities".	Witmer and Mellinger, 2016
	"Organisational resilience refers to a business's ability to adapt and evolve as the global market is evolving, to respond to short term shocks – be they natural disaster or significant changes in market dynamics – and to shape itself to respond to long term challenges".	Australian Government, 2018
"The speed at which a system returns to equilibrium after a disturbance away from equilibrium".	D'Lima and Medda, 2015	
Resilience engineering	"The intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions".	Hollnagel et al, 2011

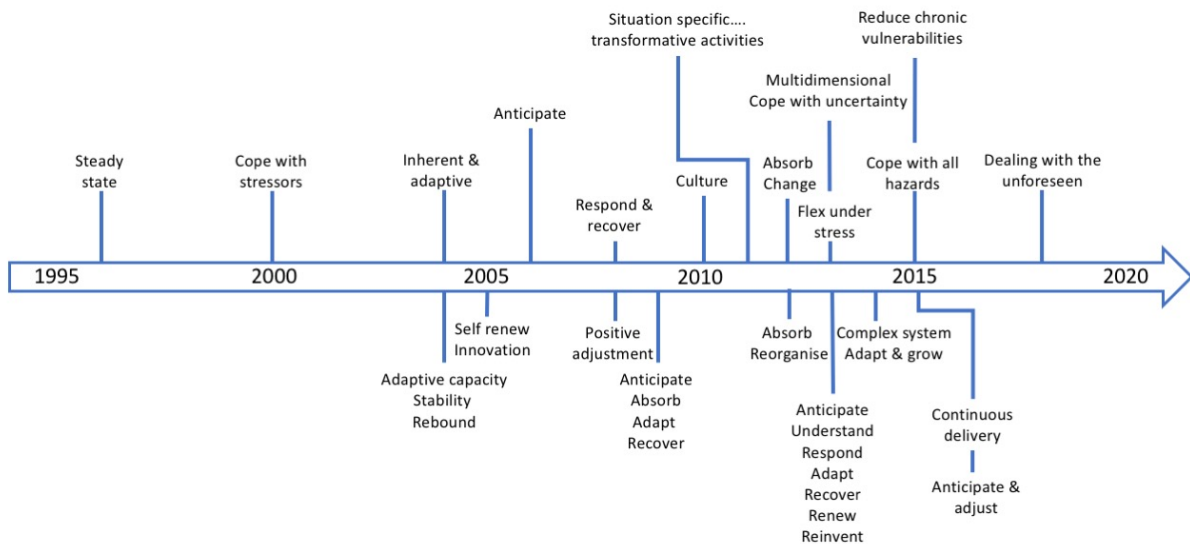


Figure 2: Evolution of resilience definitional concepts

Curiosities and false starts in resilience

There have been some 159,000 papers and articles published with ‘resilience’ in the title¹⁰. Some of these papers contain great wisdom, whilst many are misguided (at best) or less than worthless. Some ideas about resilience have not been adequately challenged and have persisted, particularly in some of the populist and pseudo academic publications. At first glance these ideas and assertions appear reasonable, and have been referenced so frequently that they have taken on a degree of (undeserved) authority. However, critical thinking¹¹ does start to open up some of the myths, misperceptions and misconceptions about resilience.

There is still a significant number of publications that present resilience as some sort of constant capability that be easily assessed, built, and ‘used’ to provide a general protection to an organisation. However, much of the published work on resilience still ignores the concept that resilience is a dynamic quality, it will only be present for a certain amount of time and then only in certain conditions.

Where the predominance of thinking about resilience has been on the ‘what’, new thinking now needs to look to the ‘why’ and ‘how’.

Linear vs complex thinking

Since the enlightenment¹², the world has been increasingly thought of as mechanistic and orderly (the clockwork universe concept), with a view that all phenomenon can be broken down into their component parts and explained through reasoning (Botla, 2009; Kilman, 2001). This so-called Cartesian-Newtonian thinking¹³ leads us to the perception that sequences of causes can be traced

¹⁰ Based on a Google Scholar search conducted on 1 June 2020, with a substantial increase in searches during the COVID-19 pandemic.

¹¹ The reader is encouraged to read a paper on the misleading and nonsense concepts promoted in other types of published literature (Pennycook et al, 2015).

¹² The period in the 17th and 18th centuries in the western world when tradition and blind faith in religion gave way to reason and individualism.

¹³ From the influence of René Descartes and Sir Isaac Newton.

back from the events they cause, and that events can be predicted from common causes. This type of thinking considers that systems are simple (i.e. linear), where cause-and-effect can be explained and described as a sequential progression. This linear thinking underpins much of the risk management tools popularised by international Standards and the COSO framework¹⁴, and is the foundation of preparedness strategies such as business continuity management. Unfortunately, this linear thinking still persists in some resilience concepts, with the belief that resilience can be created in the manner one would build a machine – by bolting separate component parts together¹⁵. Multiple fields of science, as well as the personal experience of a majority of humanity, now show us the flaws in such reductionist thinking (Gregory, 2007).

Cartesian-Newtonian thinking works well when considering simple linear mechanical or technical systems (for example disaster recovery planning for IT). However, once we start to consider natural systems, human systems, and organisational systems, our world is often chaotic, usually complex, always filled with uncertainty, and is often unpredictable. The vast majority of organisations are complex systems, with highly interconnected and non-linear relationships and dimensions (Crichton et al, 2009). The eminent mathematician Benoit Mandelbrot (of fractals fame), presented a unique way of looking at complexity. Once we start to look deeply at a complex system, we see that the complexity continues at smaller and smaller scales within that system, which is a crude example of fractals. Fractals are present throughout the natural world and are deeply embedded within the majority of organisations. Fractals present immense complexity that is built from the simplest of relationships, but to try to describe such complexity by simplistic dissection of the system will not provide any insight into reality. Systems built upon fractals (from economics to organisational cultures) do not lend themselves to easily defined and predictable behaviours using traditional approaches (Velásquez, 2010). Even the best models (economics included) are regularly surprised. We have to accept the reality of complexity and learn to work within the limitations that it imposes.

This is the challenge for ‘resilience’ – establishing a capability that can work in routine environments (and where linear, complicated and complex systems can be found together) and yet be capable of adapting to deal with both everyday complexity, and the type of complexity that prevails under non-routine conditions.

The 'standardisation' of resilience

As we have seen occurring within the business continuity management ‘industry’, there is a recent trend to assume that standardisation¹⁶ is the most effective way to deal with disruption and resilience. Remember, this is standardisation that often creates linear processes to try to deal with complex non-linear systems and complex non-linear conditions. For example, a recently released Standard has been marketed by the International Standards Organisation with the headline “*Organisational resilience made simple with new ISO Standard*” and follows up with the claim that ISO22316 “*provides a framework to help organisations future proof their business*”. As a contributor to the development of this Standard, my opinion is that this document most certainly does not provide such a framework. The document at best provides a very high level (and very limited) set of principles and attributes, with a very limited perspective of resilience. This is a common and growing problem with a number of Standards, making grandiose claims well beyond the capability of such documents to deliver.

¹⁴ Committee of Sponsoring Organizations of the Treadway Commission.

¹⁵ And yes that is a common practice in business continuity.

¹⁶ Standardisation: the development of national and international Standards. Our experience with standardisation within Australia has been highly positive, with contributions from genuine thought-leaders and to a large extent it has been an evidence-based process. However, it needs to be said that our experience with some international standards has been less convincing. Caution does need to be exercised as all Standards are not equally authoritative, and some (including some adopted by Australia) are based on significant unevidenced conjecture and are seriously flawed.

No matter how worthy the document, or how expert the contributors, implementing ‘resilience’ cannot be learned from a Standard, or from the limited training that all too follows its publication. Nor will certification guarantee that you have learned anything useful, or that you have created a resilient organisation. Resilience is an incredibly complex problem and no Standard can provide a complete solution. Slavishly following some Standards, particularly those promoting the rigid ‘management systems standard (MSS)’ approach could actually be harmful in the types of conditions where major disruptions are encountered. Conditions where agility, adaptability, creative thinking and rapid decision-making are essential, and certainly not where irrelevant and outdated plans replace sensemaking and informed decision-making.

It would be far easier to standardise and certify leadership (which is only one of many contributors to resilience). Yet despite thousands of years of exploration and forests felled for publications, no one has come even close to the planned design and creation of the consistently perfect leader.

Business continuity management is not resilience

As the organisational resilience ‘bandwagon’ grew over the last decade or so, there were some that eagerly jumped upon it, adopting the resilience moniker to rebrand tired old business continuity management (BCM) thinking. Subsequently, this evolved into promoting business continuity as the key component of organisational resilience. Whilst common sense has prevailed in many quarters, there are still some ‘old guard’ holding onto outdated beliefs about the primacy of BCM in ‘building resilience’. Even today some organisations have a resilience unit in their structure, which is just thinly disguised continuity management.

Whilst BCM may provide benefits in a very narrow band of conditions (although the evidence for its effectiveness is far from compelling in many cases¹⁷ once the context moves beyond simple linear relationships). BCM is but one tiny speck in an array of capabilities that contribute to resilience, and on its own BCM is inadequate to achieve resilience (Dominguez and Patricia, 2016; Fiksel et al, 2014; Shaw and Harrald, 2004) and with a potential for failure in broad based disruptions (Alesi, 2008). The sheer rigidity and impracticality of many contemporary BCM arrangements are highly problematic for the agility, flexibility and adaptability required for effective resilience.

Resilience is not ‘bouncing back’

Some of the earlier resilience literature has discussed the concept of ‘bounce back’, a resilient system being able to return to its original state after a disruption (Margolis and Stoltz, 2010; Wildavsky, 1988). Now it may be fair to say in psychological resilience, that a good attribute is the ability to recover back to a normal psychological state that was present before a trauma, or in engineering resilience for a metal beam to retain or regain its exact shape and function after being deformed. However, the validity of the ‘bounce back’ concept does not hold true for many of the other resilience domains, including organisational and community resilience. Although, still promoted by some pundits, ‘bounce back’ really demonstrates a highly limited, unrealistic, and naive view of resilience.

For example, consider a humanitarian disaster, where those likely to be most affected are the poorest members of a particular society. Do we really want to advocate a post-disaster ‘bounce back’ to the same vulnerable poverty stricken conditions that existed previously? Similarly, are we really

¹⁷ See Gibson and Gibson 2020; Gibson, 2018; Lindstedt and Armor, 2017; Corey and Deitch, 2011; Zhang et al, 2009; Boin and McConnell, 2007; Chang and Falit-Baiamonte, 2003; Webb et al., 2002; Tierney, 1997; Dahlhamer and Reshaur, 1996.

advocating for an organisation to ‘bounce back’ to the same routine state that proved so vulnerable in a recent disruption. The concept of ‘bounce forward’ (Davoudi et al, 2012) for resilience was introduced to suggest movement to a new state, but is a poor analogy for undertaking a controlled and purposeful adaptive change and organisational transformation. Please let us abandon the idea of ‘bouncing’ anywhere, and instead focus on purposeful and thoughtful direction.

Resilience is not always good

Well it is obvious and common sense, everyone wants resilience, because being resilient is good! Well not always. In some circumstances resilience could be a disadvantage. Strengths can be a weakness when they are not appropriately applied, or taken too far. Being too resilient can mean next to no stress on the system. Without some form of stress, the system will remain in its current state, even when change is required to drive improved ways of operating, or to exploit new areas of opportunity.

The ‘wrong’ resilience

There is also the danger that a substantial focus on ‘resilience’ can occur without properly understanding what resilience actually involves. This lack of understanding may force effort along an inappropriate path, create a false sense of security, reduce vigilance, introduce more vulnerability, stifle effective prevention and preparedness, and apply scarce resources to ineffectual activity (for example, having a complete reliance on outdated BCM practices). Conversely, too much resilience may also stifle innovation, particularly for those organisations that embrace disruption and operate at the ‘edge of chaos’ (Wilding, 2006; Conner, 1998).

The growing predominance of resilience language can also blind people to the real issues and foster false confidence. The concept of “because its resilience” often legitimises poor decisions and bad practices, preventing any real scrutiny. A similar phenomenon can also occur in some risk management practices, where blindly following standardised processes creates the false assurance that the organisation is actually managing risk effectively.

There is also the argument that many common approaches to resilience just deal with the effects of disruption, whilst continuing to ignore the contributing and influencing factors. This reactive perspective on resilience could encourage a resigned acceptability of disruptive conditions, rather than dealing with their origin. Meaning that an ever-increasing investment in ‘fixes’ will be required to deal with ever escalating problems.

Pronouncements on future resilience – crystal ball measurement

There are many ‘purveyors of solutions’ claiming that their particular tool can measure resilience and declaring that this or that organisation has “high resilience”. Such pronouncements often occur just before some disaster and the catastrophic failure of the resilient organisation. These ‘measures’ of resilience are usually based on examining the organisation’s capabilities in the routine state. Besides being possibly delusional, such assessments usually fail to say against what conditions the organisation is highly resilient. Asking the question (what is resilient to what?) is the most overlooked yet fundamental issue in estimating any *potential* for resilience (Strigini, 2012; Walker, 1998). To describe any form of resilience, one needs to be able to define (Figure 3):

- The *subject* of resilience: what is actually resilient.
- The *object* of this resilience: to what or against what this system is resilient i.e. the nature or context of the disruptive conditions.
- The *purpose* of this resilience: what has or will be achieved.

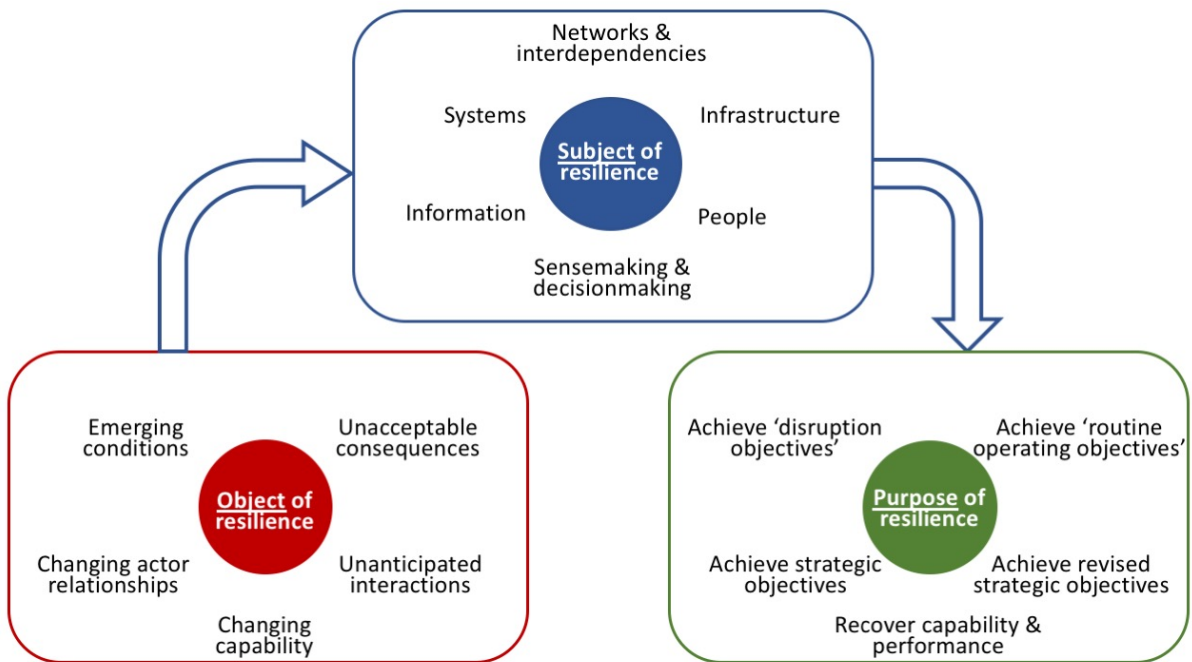


Figure 3: defining the nature of resilience

Assessing and measuring resilience

Assessing resilience is fairly well researched and established in some disciplines (Bozza et al, 2015; Franchin and Cavalieri, 2015; Windle et al, 2011; Fredrickson, 2001), such as civil engineering (measuring linear relationships) and psychology (where the relationships of risk factors and protective factors have been the subject of research for over one hundred years). In such cases providing an assessment of resilience (before an event) may be acceptable, and certainly as valid as any other psychological or psychiatric predictive assessment.

Approaches for measuring resilience in sociotechnical systems have largely been based upon assessing the presence of inputs into the system, including physical resources, processes, structures, etc. (Proag, 2014a; Stephenson, 2010). Measuring the performance or potential of contributing individual elements and capabilities, such as assessing system agility (Jobidon et al, 2013), can only provide a rough indication of the *potential* for future resilience. It does not provide a measure of resilience.

For more complex systems, such as communities and organisations, traditional organisational analytics are not capable of anything approaching a true *predictive* measurement of resilience (Arizzi et al, 2014; Park et al, 2013), despite the wild claims of some other authors. If we accept that resilience is an emergent property of complexity (which most credible authors do accept), then resilience is greater than the parts of the system that contribute to it, and cannot be predicted on the basis of the behaviour of each of those parts considered in isolation (Haines et al, 2008; Paries, 2006). These system elements cannot be 'decoupled' and measured in isolation from the broader environment in which they will need to operate (Hummel et al, 2015). The requirements for any assessment of resilience needs to be strongly grounded in the context in which it is being applied, since the same complex system may demonstrate high resilience to one type of challenge, but be highly vulnerable to a different challenge, or in a different context, or at a different time.

Accurately predicting the future resilient behaviour and performance of complex systems is almost an impossibility – except after a system has been placed under specific stresses that 'overload' it and

resilience emerges (Huber and Khun, 2017). Thus, measuring resilience is only truly possible in hindsight, and usually impossible in foresight.

Quantification models, such as those used on the London Underground system (D’Lima and Medda, 2015), propose an approach based on measuring the behaviour of the system (such as speed of recovery) following the experience of disruptive events. However, any attempt at measuring resilience based upon past performance also needs to exercise great caution, as evidence abounds that past experience of resilience to disruptive events does not predict future resilience performance (Lechner et al, 2016), the Fukushima reactor disaster being one case in point (IAEA, 2015; Kurokawa, 2012).

We can only say with any certainty that an organisation *demonstrated* high resilience to the disruptive event that has already occurred. This does not mean that it will demonstrate anywhere near the same resilience for other types and scales of disruptive events, or even to a similar reoccurrence of the original event. Any assessments that make absolute claims about future resilience performance are at best naïve, and may lead to a focus on the wrong capabilities, and eventual degraded resilience. At best, future resilience can only be expressed in terms of probabilities, not in complete certainty. Claiming a definitive measure of resilience *ex ante*, trying to predict, based on a small sample of the vast complexity of an organisation, looks a lot like fortune telling. “Let us gaze into the crystal ball and your resilience will be revealed”! Fortune telling is a world populated with the misguided, the misinformed, the gullible, and the charlatan.

The only resilience assessment or estimate that can be made is an indication of the capability for future potential resilience (Somers, 2009). This does not provide a measure of actual resilience.

Evolving resilience models

The general absence of an agreed unified concept of resilience has resulted in a multitude of different models being proposed. Some useful, many naively simplistic and narrowly focused. No resilience model can represent reality and capture all of the complexity that embodies resilience. All models are artificial constructs that represent simplified abstractions of reality. They are a way of simplifying a highly complex multidimensional concept into a short descriptive narrative. As the consummate British statistician George Box said, “all models are wrong, some are useful” (Box and Draper, 1987). The usefulness of these models is that they provide a lens through which resilience can be further explored. Such models are framing tools that “cannot capture all the dimensions of resilience” (Albani and Kupers, 2014), but they can provide an entry point. Over the last two decades there has been a continual evolution of some of these resilience models.

Resilience may also be considered in terms of different types of disruption, against which it is manifested, including: intensity of the disruptive effect; the span of time over which the disruption occurs; the scope or extent of the disruption; and the speed of onset of the disruption (Barroso et al, 2011).

Since resilience arises from the almost infinite number of ways that a complex system can interact with other complex systems (such as those generating disruptive conditions), each interaction could theoretically result in a different aspect of resilience being prominent and recognisable under different contexts (UK Government, 2012). Hence, different models may illustrate aspects of resilience that have a different importance under different conditions.

However, caution needs to be exercised as the vast majority of resilience concepts, measurement tools and analytical frameworks are based upon simplified "low dimensional" extracts of a very complex multidimensional reality (Gao et al, 2016), and can never capture the breadth or depth of contributing and influencing factors and their interactions.

However, with this limitation in mind, the various resilience models are worth exploring as they each give an insight into different aspects of this convoluted resilience puzzle, parts of which will predominate under different conditions. These various models can be characterised into related 'families' of ideas (Figure 4), which include:

- Soft/hard capability models.
- Scalar models.
- Categorisation models.
- Conditional models.
- Systems and subsystem models.
- High reliability models.
- Resilience engineering models.
- Attribute models.
- Domain specific models.

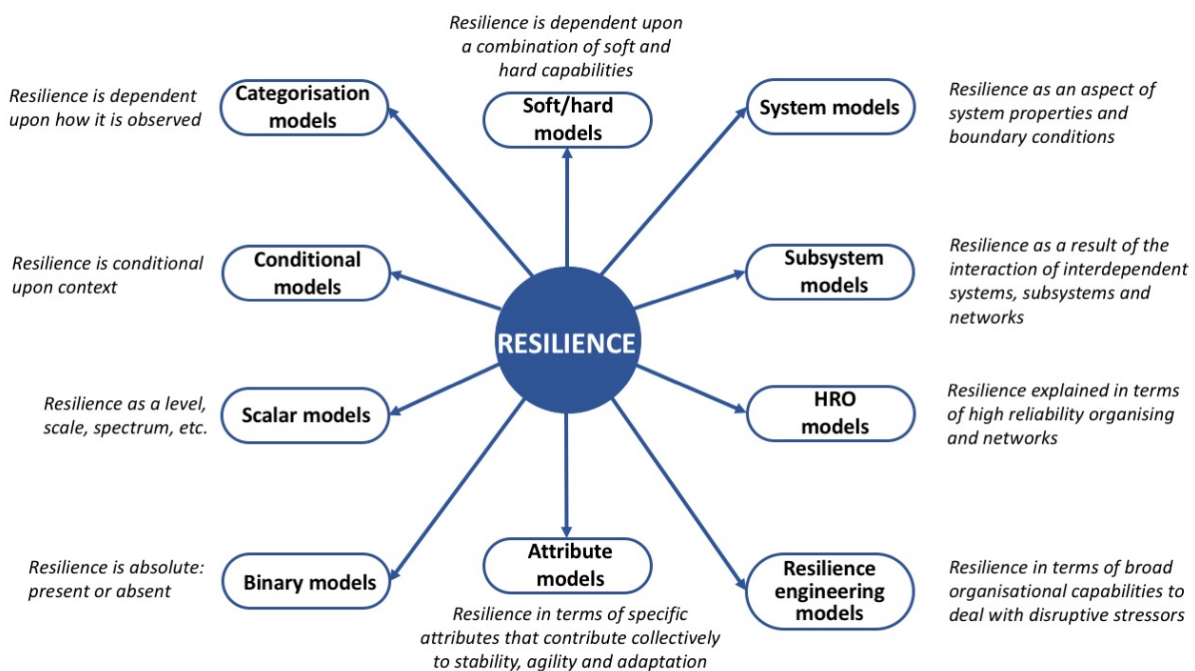


Figure 4: Overview of resilience models

Soft/hard capability models of resilience

It has been suggested that resilience takes two broad forms: 'hard resilience' associated with the strengthening of structures and infrastructure, and 'soft resilience' associated with a system's ability to absorb, adapt and recover (Moench, 2009). Independently, Gibson and Tarrant (2010) discussed a number of emerging resilience models that combined concepts of hard 'what we do' (structural,

functional, procedural, and resource) contributing elements, along with softer ‘how we go about it’ contributing elements (cognition, decision making, leadership, teamwork, trust, etc.). An updated adaptation of the combined models thinking is provided in Figure 5.

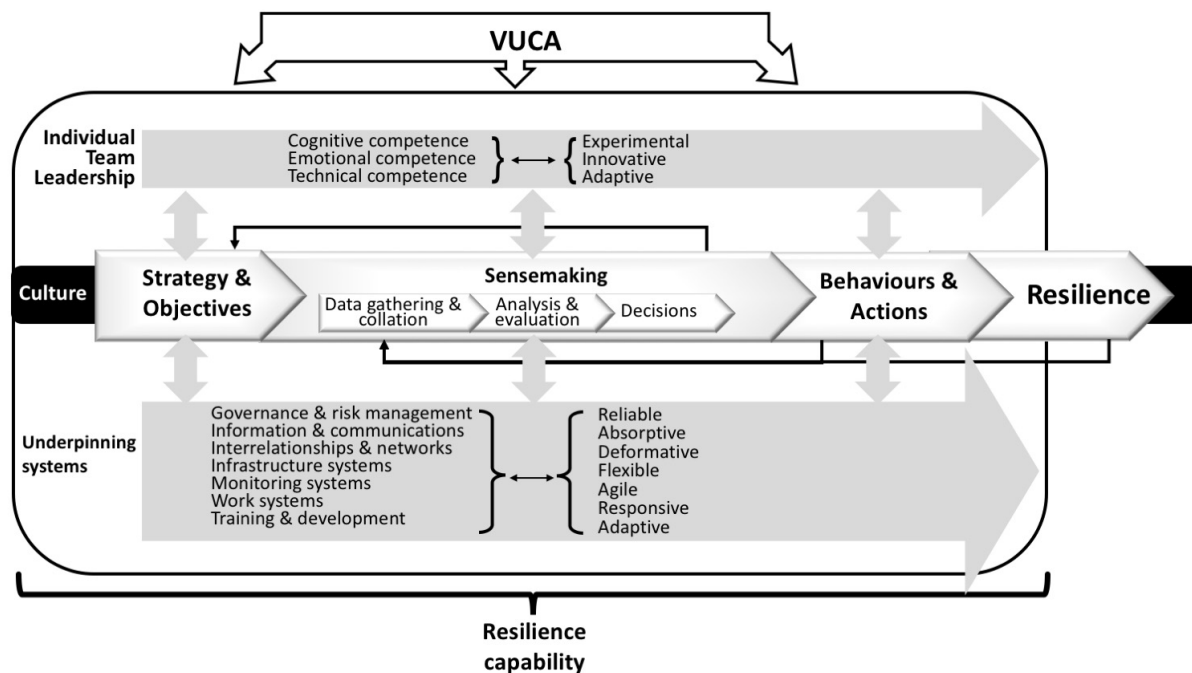


Figure 5: VUCA¹⁸ resilience model

Scalar models of resilience

One of the most common mistakes is to view resilience as a binary concept (Bourbeau, 2013), where a system (or element of a system) is regarded as either ‘resilient’ or ‘not resilient’, rather than thought of as a scale or spectrum of resilience (for example, ‘low’, ‘medium’, high’). Just as disruption can be experienced over a range of scales, so too can resilience, where the same system may demonstrate different types and levels of resilience under different conditions, and over different time periods. Different types of resilience may also be exhibited by a system in response to a repeat of the same type of disruptive event.

It is important to consider over which scale resilience is being considered, or which scale applies to a particular context. For example, an organisation may demonstrate immediate resilience to a catastrophic failure of critical infrastructure, but not be resilient over the long term (for example, revenue progressively reduces due to increasing numbers of customers failing due to the compounded effects of the original disruption). Similarly, a single company may demonstrate poor resilience to a disruption, to which the wider sector proves to be highly resilient.

¹⁸ VUCA: a way of describing the context (strategic and operating environments) has high Volatility, Complexity, Uncertainty, and Ambiguity. Alternate concepts include TUNA (Turbulence, Uncertainty, Novelty, Ambiguity). This is characteristic of the conditions from which disruption often emerges, and the conditions that many organisations are increasingly facing.

When considering scale in resilience the effects of interconnections and feedback loops between different levels of the scales also need to be considered, as the lowest level of scale may have a profound influence on the highest level of scale, and vice versa. In complex systems, emergent behaviours (both beneficial and harmful) often arise from within these interscalar 'feedback loops' (Albani and Kupers, 2014).

There are several different scalar models of resilience:

i) Durational scale resilience model

Resilience can be expressed as an outcome with a *duration* of different periods of time, for example:

- **Short term resilience:** the affected system is able to cope with disruptive conditions and their effects for a short period of time (duration of hours or days). However, if the disruption is more prolonged, then capability and performance may progressively degrade to the extent that the system is no longer regarded as resilient. For example: *"we survived the flood but could not get our customers to return"*.
- **Medium term resilience:** the affected system is able to cope with the disruptive conditions and collateral effects for weeks to months following a disruptive event. However, it proves to be unsustainable in the longer term. For example: *"after the new tech startup appeared, we continued to have good sales for the following 6 months, but then our customers just seemed to disappear"*.
- **Long term resilience:** The affected system is able to achieve a sustainable and acceptable mode, and level of operation for a prolonged period of time. For example: *"we have not just survived but continued to grow despite the severe economic downturn in the local economy over the last few years"*.

ii) Temporal onset scale resilience model

Resilience can also be expressed according to different times of *onset* of the outcomes, for example:

- **Precursor resilience:** a system is able to affect emerging conditions before they exceed a disruptive threshold. For example, a society addresses social conditions before civil unrest develops.
- **Immediate resilience:** A system may respond effectively to conditions immediately they become disruptive. For example, backup power capability allows an organisation to keep operating during and in the immediate aftermath of a widespread power failure.
- **Delayed resilience:** A system is adversely affected during and in the immediate aftermath of a disruption (i.e. shows low resilience), but is able to demonstrate increasing resilience as the disruption progresses. Delayed resilience often occurs where, for instance, external resources become available to assist in recovery. For example, *"although our community was devastated by a bushfire three years ago, most of the houses lost have since been rebuilt, old residents have returned, a good level of commercial activity has been reinstated and we continue to attract new residents, businesses and tourists"*.

Duration and onset scales are non-exclusive and are often seen together as a resilience characteristic.

iii) Focal scale resilience model

Different levels or viewpoints of a system may demonstrate different levels of resilience, such as where a system exhibits high resilience at a macro scale, but demonstrates lower resilience at a microscale (and *vice versa*) under the same conditions. For example, an organisation may demonstrate overall high resilience, whilst a number of its systems or functions demonstrate low resilience and are severely impaired by changing conditions.

A key aspect of focal scale resilience relates to how the different scales interact and influence each other (Walker et al, 2004). Different scales may also demonstrate changing resilience over the duration that disruptive conditions are present. Activities that strengthen or promote resilience at one scale, can result in resilience being degraded at another scale, and can hide other more fragile and failing elements of the system at another scale. For example, focal scale resilience could be expressed in terms of structural, hierarchical and geographic scales (Figure 6). Or in terms of other scales, such as:

- *Flow scale*: sub-process, process, function, system, multisystem, etc.
- *Spatial scale*: office area, floor, building, site, road, neighbourhood, city, region, etc.
- *Industry scale*: company, alliances, sector, economy, etc.
- Multiple combinations of any of the scalar models.

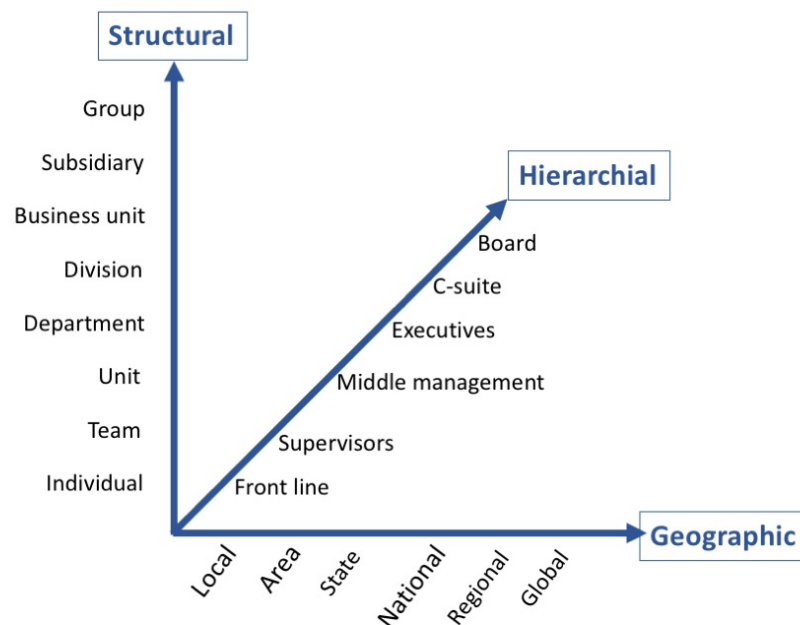


Figure 6: Focal scale resilience – organisational example

iv) Threat scale resilience model

Resilience may be observable along a threat scale, where a system proves to be resilient to some aspects or effects of a disruptive event, but highly vulnerable or susceptible to other aspects (different foci of threat). Variations in resilience may also be observed during the evolution of developing disruptive conditions, where resilience fluctuates as the nature of the conditions change during a disruption.

Categorisation models of resilience

i) Origins schema models

A number of publications consider different aspects of resilience according to the origin of this resilience (Patel et al 2017; Matelli, 2016; Giezen et al, 2015; Lampell et al, 2014; Walker and Salt, 2012; Rajamäki et al, 2012; Pellissier, 2011; Burnhard and Bhamra, 2011; Grafton et al, 2010; Sapountzaki, 2007; Rose, 2007; Adger et al, 2005; Rose, 2004; Klein et al, 2004). The origins schema models suggests that resilience could occur as one or a combination of:

- ***Inherent resilience***: pre-existing capability of the system, usually arising from a combination of:
 - innate resilience: the capability for resilience that is already present in a system. Not having been purposely designed for specific resilience, it is often an unplanned ‘bonus’ supplementary to the main functional purpose of the system element;
 - designed resilience: resilience capability that is purposefully planned and incorporated into the system’s design and build.
- ***Reactive resilience***: the resilience capability is enacted as a direct response to the stress of a potential disruption, for example deploying contingent arrangements.
- ***Evolving and adaptive resilience***: the system adapts to the changing conditions, introducing additional or different capability and thereby increasing resilience to the stressors.

ii) **Elemental schema models**

Elemental schema portray resilience as a result of the elements or components of a system and include different types of ‘lenses’ through which resilience could be viewed (Albani and Kupers, 2014):

Structural resilience model:

The structural resilience model postulates that resilience arises through the collective contributions of the tangible elements of the system, such as infrastructure, built environment, plant, networks, people activities, processes, organisational structure, etc. A key aspect of structural resilience is often the presence of modularity (US National Park Service, 2017; Witt and Smith, 2017), where individual systems elements can be compartmentalised into discrete clusters (or modules). Should one module fail or have errors present, it can be isolated from the operation of the whole system, and ‘fixed’ or replaced with minimal disruption.

Integrative resilience model:

In the integrative resilience model, it is the manner in which a system’s elements relate to each other, interconnect and interact, and their interactions with other systems, that contribute to resilience. These interactions extend the thresholds at which change would otherwise have a degrading effect on individual elements in isolation. That is, collectively the elements are better able to cope with the stressors, than they are as separate elements (i.e. one of the key attributes of a complex system). The concept of social capital (Adger, 2000) illustrates these interconnections within human systems by way of the development of ‘trust’, ‘sociability’, ‘collective commitment’, and ‘reciprocity’ (Chen et al, 2013), and other resources that are created, by or only accessed through social networks (Norris et al, 2008) and that collectively enhance resilience.

Transformative resilience model:

The transformative models are associated with resilience that occurs over the longer time frame of a disruption and beyond. This includes a system’s ability to apply foresight and anticipate, experiment with solutions, reorganise, adapt and ‘reinvent’ itself. From an organisational perspective, part of the system’s ability to transform lies in the extent of its polycentric governance (Ostrom, 2010), providing multiple points of authority and decision-making within the system. Such distribution of decision-making increases agility and flexibility, allows for more experimentation and innovation, and is more suited to the demands of complex environments, compared with the more restrictive hierarchical decision approaches that operate successfully in more linear environments.

iii) **Trajectory schema models**

Trajectory models of resilience propose that different aspects of resilience can become apparent over time, during and in the aftermath of a disruptive event. Variations of this model have been particularly

explored in the response to psychological stress (Norris et al, 2009; Layne et al, 2007) where, following exposure to a potential trauma, an individual can follow a number of possible trajectories. Similar trajectories can be ascribed to other domains and types of systems:

- “Resistance”: where the onset of disruption or dysfunction is prevented or minimised because of the system’s capabilities to block the effects of the stressors.
- “Recovery”: the return to pre-event¹⁹ or normal functioning, following a period of disruption or dysfunction.
- “Relapsing/remitting”: where the dysfunction or disruption is ‘managed’, but recurs and follows a cyclical or repeating course of disorder.
- “Delayed dysfunction”: where further dysfunction or disruption emerges sometime after the disruptive period has passed. In psychological terms this is often represented by post-traumatic stress disorder (Orcutt et al, 2004).
- “Chronic dysfunction”: where the disruptive impacts persist for long periods of time beyond the disruptive event.

Conditional models of resilience

Conditional models explain resilience in terms of the different states that a system may experience in relation to its context, stressors, etc.

i) Capability resilience model

Capability models portray resilience in terms of the different capabilities that may exist prior to, or after a disruptive event (Boin and Van Eeten, 2013):

- “Precursor resilience”: characterised by a capacity for disruptive shocks to be absorbed ‘gracefully’, and for change to be accommodated without a catastrophic failure.
- “Recovery resilience” where different structures, capabilities and strategies are used to restore required performance following a disruptive event.

ii) Static versus dynamic resilience models

In these models a system may demonstrate resilience in two broad ‘forms’ (Rose and Krausmann, 2013; Rose 2007):

- ‘Static’ resilience where the system is able to maintain function (as is) in the face of a stressor (such as a sudden unexpected shock) and ‘resilience’ is achieved without repair to, or adaptation of the system.
- ‘Dynamic’ resilience where the focus is on maintaining efficiency as conditions change, even though the nature of the function may change.

iii) Specific resilience versus generic resilience models

This is more of a concept about how we observe resilience in action and how we try to describe it, than an actual property *per se*. Specific resilience is resilience that is ascribed to a specific challenge (for example resilient during an earthquake), whilst generic resilience relates to the capability to deal with a wide range of different challenges (Böggemann and Both, 2014).

¹⁹ Note that whilst a return to the previous functioning state may be appropriate in psychological and engineering terms, the concept of ‘bounce back’ has little relevance for many other systems. Recovery in such systems instead becomes the transition to a new acceptable or desired state.

System models of resilience

A great deal of the literature on resilience, considers the subject matter from a systems²⁰ perspective. A system is often defined with respect to assigned boundaries. However, many systems encountered in the day-to-day life of an organisation (which is itself a system) are open systems where the boundaries are ill defined and extremely porous, interacting and exchanging with other systems.

When a system, such as an organisation (or parts thereof) is operating within the expected conditions for which it is designed – i.e. day-to-day operations, this is often referred to as a ‘business-as-usual’ or the ‘routine’ state. When a system boundary is exceeded, feedback mechanisms promote a change in structure and functionality of the system – driving it to different transition states (Walker et al, 2006). When a system is subject to conditions that exceed those expected ‘designed for’ boundaries, and functionality degrades below an acceptable threshold, this is referred to as a ‘disrupted state’. Where a system’s functionality and performance remain within acceptable limits under such potentially disruptive conditions- it is referred to as a ‘resilient’ state (Folke et al, 2010).

A resilient system has been defined as one that has a reduced probability of failure, but should failure occur – the system experiences reduced adverse consequences, and takes less time to recover (Bruneau and Reinhorn, 2007). It has been proposed that system resilience can be explored through applying a ‘dimensional lens’ based on what types of stresses a system is exposed to (‘resource stresses’, ‘societal stresses’, ‘acute event stresses’, etc.) and how the system responds to these stresses (Albani and Kupers, 2014).

i) The property perspective

There is a common assumption that resilience is a property of a system and networks of systems, and as a property it can be detected, observed, described, measured and, ultimately, developed and built (Fraccascia et al, 2018; Darling and Côté, 2018; Ganin et al, 2016). Conversely, it is also arguable that resilience is a socially constructed artefact (Christmann et al, 2012; Walklate et al, 2018; DeVerteuil et al, 2016). Resilience is really a label an observer gives to the system’s performance under stress, relative to an arbitrarily decided threshold. The observer makes an arbitrary decision (based on a range of assumptions) about what constitutes resilience and what does not. As such, resilience only exists in the mind of the observer, and as the observer’s perspective changes, so does the concept of resilience. This may go part way to explaining why the concept of resilience, particularly with respect to organisational resilience, has been so difficult to tie down and achieve an agreement on definition, ‘composition’, and the ability to achieve a state of being ‘resilient’.

Some organisations do perform better than others under both routine and some non-routine conditions. They achieve this through a wide range of interrelated, interdependent and intersecting capabilities, that when applied become detected as properties of the system. As conditions vary, so different system capabilities and hence properties may behave differently. At different times and under different conditions, different system capabilities will contribute more or less to the observed organisational performance.

ii) Trade-off

The concept of ‘trade-off’ is often neglected in considering resilience. A ‘resilience attribute’ that provides advantage under one set of conditions for a system, may provide a disadvantage under other

²⁰ Where a system is a collection of interdependent and interacting elements that work together to form a unified entity, the functionality of which is usually different to and greater than the functionality of its separate component parts.

conditions. Resilience therefore becomes a trade-off between the collective benefits and disbenefits of a system's attributes. The balance of this trade-off may be an advantage under some conditions (contributing to increased resilience), but a disadvantage when these conditions change (contributing to lowered resilience). Such trade-off can be seen in the tension between allocating resources to improve BAU efficiency and productivity, versus investing in adaptive capacity to deal with future challenges and stresses (Patterson and Wears, 2015). For example, maintaining surge capacity would provide advantage under conditions of sudden workload demand, but would be a resource and financial burden under conditions of declining workloads. In other words, resilience capability comes with a price.

The ETTO principle, '*Efficiency Thoroughness Tradeoff*' (Hollnagel, 2009), describes the balance in decision-making and operating between 'being efficient' and 'being thorough'. As efficiency (with a focus on reducing cost and time requirements) is elevated, then thoroughness (time and resources spent on situational awareness, sensemaking, thinking, planning, error detection, etc.) decreases. Conversely, as the focus on thoroughness increases, efficiency will necessarily decline. As conditions change, the balance between, and the relative importance of efficiency and thoroughness is likely to change. Being able to deliberately adjust this balance appropriately to changing conditions would make an important contribution to resilience.

iii) Innate variability

Recent thinking in safety systems, such as 'safety II' and 'resilience engineering' considers that the innate variability of a socio-technical system is a source of both 'success' and 'failure' (Lundberg and Johansson, 2015). Extrapolating the concepts of error and safety from safety II thinking (Dekker, 2015) we can visualise some of the difficulties in trying to 'build resilience'. All systems will tend to transition to lower resilience and failure over time in the absence of continuing attention to detect and anticipate change, and a continual evolution of systems capability to accommodate that change. Thus what may be regarded as 'high resilience' today will progressively degrade if not sufficiently maintained and adapted.

iv) Sustainability

Many systems demonstrate the ability to survive and thrive over long periods of time, dealing with substantial variations in conditions. In such cases the term 'sustainability' is often applied. Some authors regard 'sustainability' and 'resilience' as completely distinct concepts, even at times antagonistic to each other (Elmqvist, 2017). 'Sustainability' has been regarded as maintaining an unchanging state (Harm and Craig, 2014), whereas resilience has been viewed as an ability to deal with unexpected or 'surprise' variability. Conversely, other authors see the two concepts as complementary, with a recognition that resilience can make an important contribution to sustainability, and sustainability can make an important contribution to resilience. However, neither resilience or sustainability is sufficient alone to establish the other (Derissen, 2014).

v) State transition models of resilience

When a system is affected by changing conditions, it can either resist or absorb the effects of change and remain in the same state, or it can transition to a different state. That different state may be stable and become established, or may be unstable (or undesirable) and exist only temporarily before transitioning to a new different state. These transitions will continue to occur until a stable end state is reached, or until the system degrades and eventually collapses.

When stressors result in system transition to a degraded temporary state – the system demonstrates low short-term resilience. If this temporary state transitions to a higher performing longer term state, then the system can be said to have regained longer term resilience. A resilient system should be continuously adapting to the challenges of its changing environment, therefore attaining a ‘stable’ end state may not be a desirable attribute of a highly resilient system. Rather this resilient system is more likely to exist as a dynamic fluid state, regularly undergoing lesser or greater state transitions as it continues to adapt.

This brings us to the concepts of equilibrium and stability that prevail in many of the domain specific concepts of resilience. Whilst a return to equilibrium, or ‘bounce back’ to the pre-existing state, may be appropriate for some of these domains (such as engineering or ecology), it is far less appropriate for socio-technical systems (such as an organisation, community, infrastructure networks, etc.). Equilibrium suggests achieving a stable state (i.e. not moving, unchanging), until forced to a new equilibrium state. When applied to sociotechnical systems, any narrow interpretation of this concept becomes self-limiting. For example, most organisations are constantly seeking to change something about their operations: to improve existing or build new capabilities, expand into new markets, streamline for efficiency, improve performance, etc. All of which require stepping out of an equilibrium state – continually transitioning to a new state. This can mean that organisations are continually transitioning across multiple equilibria, or that organisations are in a constant state of flux. Resilience concepts that promote an equilibrium concept and advocate for a return to the original equilibrium state are a poor fit for socio-technical systems and for contemporary organisations (Pendall et al, 2010).

v) Highly Optimised Tolerance Model

Many systems demonstrate highly optimised tolerance (HOT), being able to perform well in the routine operating conditions for which they were designed (Carlson and Doyle, 2002), but are highly fragile once the narrow threshold conditions are exceeded, at which point catastrophic collapse is a probable outcome. The narrow tolerance boundaries of a HOT system usually occur as a result of flawed assumptions present during the original design of the system, or during its subsequent modification.

Application of business continuity plans provide one example of a HOT system. These plans are designed with presently understood capabilities and certain potential future operating conditions in mind. If a disruption occurs that is close to these imagined conditions, then the plan would be expected to function as intended. However, if the actual conditions (or capabilities) are mismatched to the plan, plans would not be appropriate to the conditions encountered, operating boundaries would be exceeded, and the plan and the system would both fail.

The presence of HOT systems are highly problematic for resilience. An ability to accurately predict future conditions and design appropriate measures months or years in advance, is beyond the capability of most contemporary continuity management approaches. Systems with high resilience have established more extensive and more fluid operating boundaries that allow them to cope with a broader range of potentially disruptive conditions, beyond those usually associated with business continuity arrangements. This emphasises the importance of adaptive capacity which allows boundaries to continue to extend as disruptive conditions continue to evolve in novel ways.

One of the challenges for improving resilience is determining the extent of existing system boundaries, since the only effective way to determine the boundary of any system is usually to cross it.

vi) Panarchy resilience model

The panarchy model of resilience proposes that organisations experience nested loops of adaptive cycles (Holling and Gunderson, 2002), whereby change occurs through a cycle of system evolution. Most systems eventually achieve a state of maturity and become stabilised, conserved and rigid. As conditions change, this mature system is unable to change progressively, becoming ossified and eventually collapsing into a failing state. Where the system is able to respond appropriately to this failing state, the system is then able to reorganize into a new higher resilient state, with the cycle continuing to repeat over time.

It is also proposed that these cycles are nested, occurring at different scales and levels within an system²¹ (Figure 7), and that the nested phases may not necessarily occur sequentially (Davoudi et al, 2013). This suggests that over time, as a system matures, it experiences declining resilience, unless concerted and continual effort is applied to address system rigidity and conservatism.

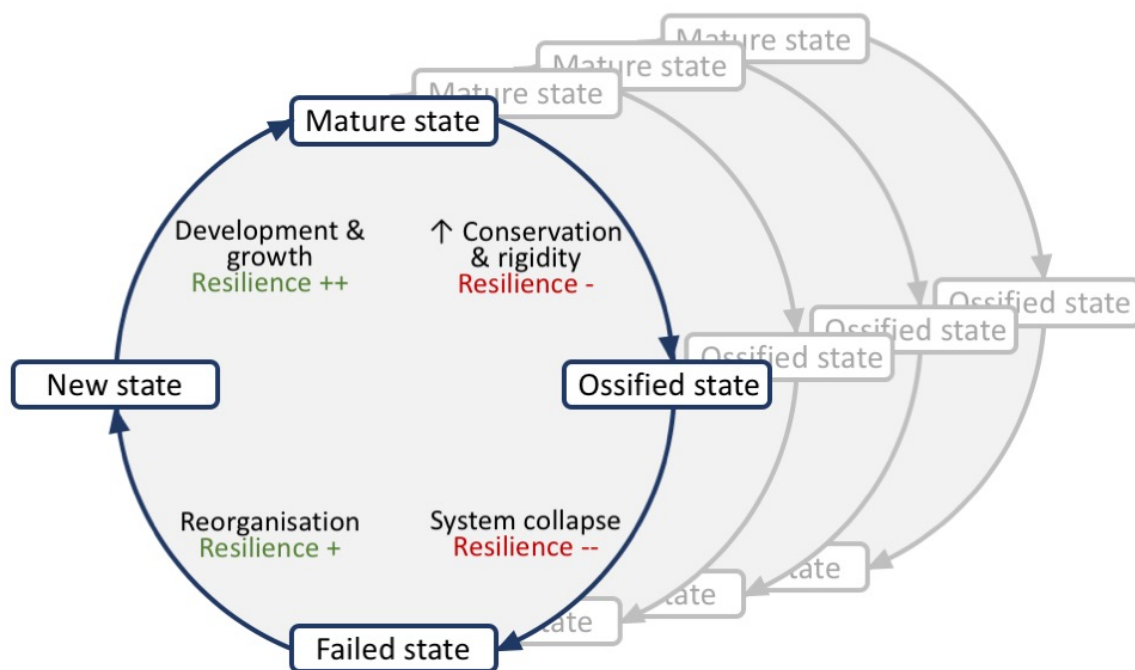


Figure 7: System maturity cycle – at multiple scales

Subsystem models of resilience

The subsystem models of resilience have similarities with some of the scalar models. The subsystem models present a resilient system as an individual, team, organisation, collection of related entities (such as an industry sector), or as networks of multiple interacting processes, information, infrastructure, individuals and organisations. These systems are in turn composed of lower scale systems (subsystems) that are capable of expressing uniquely different levels of resilience to the overall system and to other subsystems. Depending upon the context, some subsystems will collectively strengthen resilience, whilst other subsystems may weaken resilience of the overall

²¹ So could occur at a whole of organisation system level, or lower scale sub-systems

system (Linkov et al, 2013a; Vanderbilt-Adriance and Shaw, 2008; Walker et al, 2006; Larrabetti, et al, 2005; Regianni et al, 2001).

The relative benefits and disadvantages provided by these subsystems can vary over time, and vary over different conditions. It should also be remembered that within complex adaptive systems the resilience of the whole system will be different to the sum of the resilience of the individual subsystems.

i) Societal domain models

Societal domain models are subsystem models that take a macro view of resilience (Figure 8) where independently controlled domains of resilience, within a broader system of systems (e.g. a society), interact to provide a higher collective resilience. This higher collective resilience in turn helps to support and grow resilience in the ‘lower order’ domains.

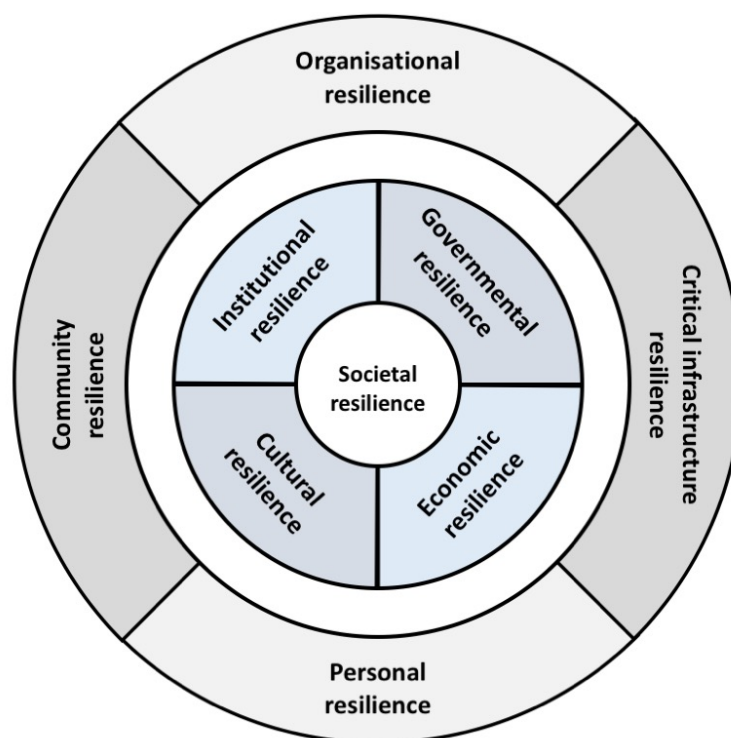


Figure 8: Hypothetical example of a societal domain model

ii) Organisational system models

Organisational resilience can also be viewed as a tightly nested domain model, where individual systems and subsystems (such as the ‘financial system’, ‘HR system, compliance system, etc.) contribute to higher order systems and to overall organisational resilience (Figure 9). Under any set of conditions some subsystems will demonstrate resilience, whilst others may be highly vulnerable. As conditions change, each subsystem may vary in its ability to express each of its ‘resilience attributes’, and each of these individual attributes may change in the relevant contribution they make to overall resilience. As the expression and relevance of these attributes can change over time (as organisational context and operating conditions change) so the resilience of the system is expected to change, improving or degrading.

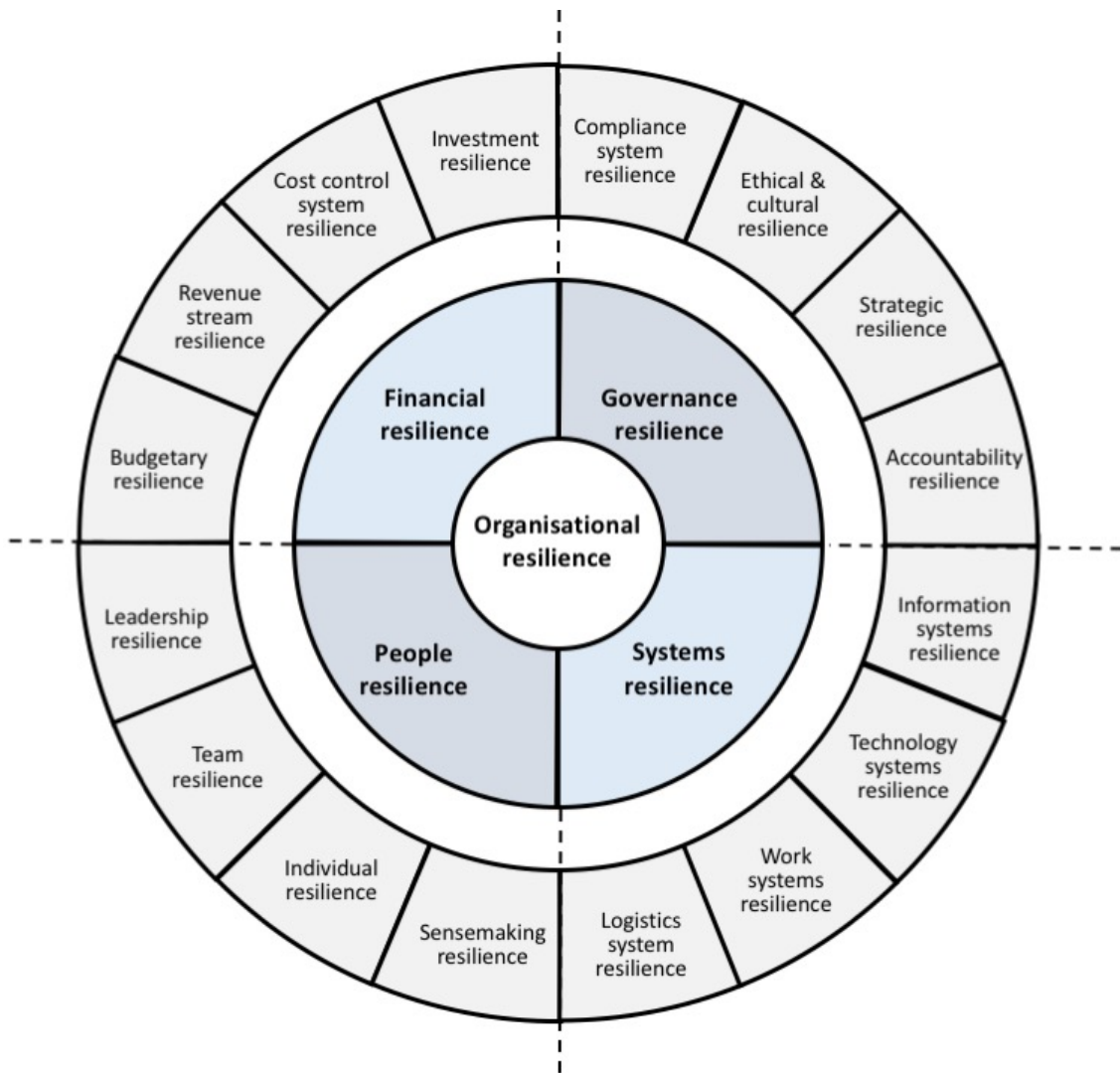


Figure 9: Hypothetical example of subsystems contributing to organisational resilience

High Reliability Organisation Models

The concepts of 'high reliability organising' and 'high reliability organisations' (HRO) emerged from the study of safety critical systems in high hazard environments. The early work on HRO involved experiences of nuclear power plants and navy aircraft carriers (Weick et al, 1999; Weick and Roberts, 1993; La Porte et al, 1988). The concept of HRO has since been extended from its original focus on individuals and organisations, to a broader concept of high reliability networks (Berthod et al, 2017). Much of the HRO research has focused on reducing the frequency and severity of accidents, although it does have a broader application for further exploring resilience. The HRO concept, both as a model and in practice has limitations (Leveson et al, 2009; Hopkins, 2007), including:

- Lack of objective criteria and data for identifying and measuring HRO performance.
- The difficulty in identifying realistic early warning indicators, and in detecting change in them in a context of weak signals and strong noise.
- The reliance on sufficient capacity and expertise dedicated to the collection and analysis of data relating to error and potential failure.

- Whilst there is significant case study evidence that demonstrates the benefits of migrating decision-making closer to those with the requisite expertise, there is also evidence of problems of decisions being made by those without an awareness of the broader implications of their decisions (Marais et al, 2004).
- Continuing ambiguity about HRO concepts and definitions.
- Reluctance to maintain an open reporting culture.
- Restrictions on the effective prioritization of goals.

However, applying the broad HRO concepts may help counter the occurrence and effects of disruption, improve reliability, and enhance organisational resilience. (Roberts and Bea, 2001).

HRO theory argues that the potential for disruption is a normal feature of systems, arising out of their complexity (Leveson et al, 2009; Dekker and Woods, 2009). As complexity increases, coupling amongst components increases, along with progressively increasing uncertainty about the nature of interdependencies and interactions (inside and outside of the system). With increasing complexity and uncertainty, comes the potential for increased vulnerability (Figure 10), and a small error or other perturbation in one part of the system can give rise to a significant failure in another part of the system (an asymmetric effect). In the ‘average’ organisation, control systems should catch and correct these small errors and remove or minimise their effects. However, as volatility, turbulence, novelty, complexity, ambiguity and ultimately uncertainty, increase, the more likely it is that these control systems will be overwhelmed, and a disruption occur.

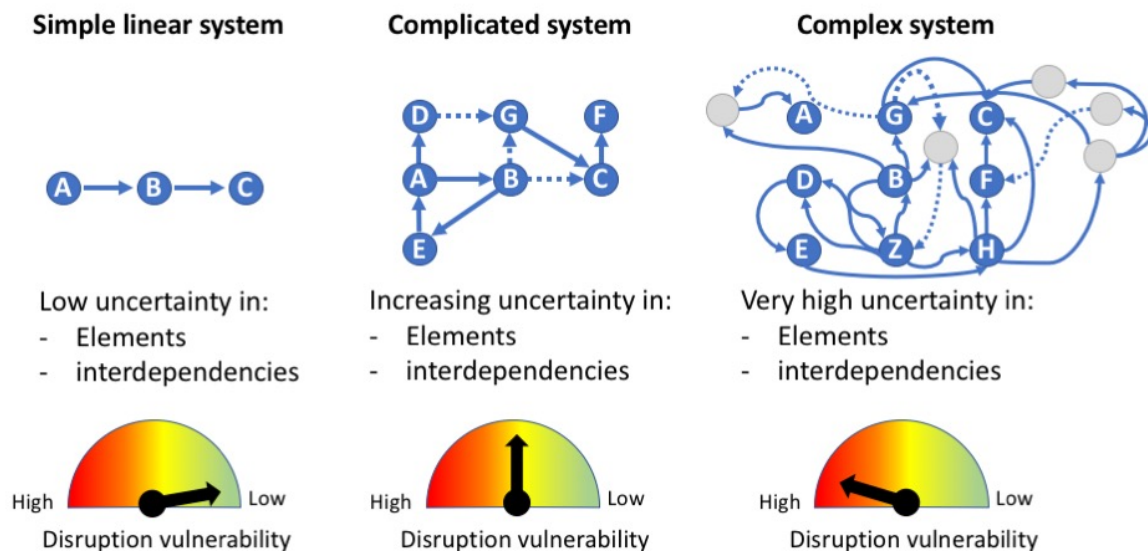


Figure 10: complexity, uncertainty and vulnerability²²

HRO provides capabilities that increase the coping ability of operations (such as in extended BAU – which extends the range of conditions over which routine operations can function), and improve resilience to otherwise highly disruptive conditions. Research indicates that high reliability

²² In simple linear systems cause-and-effect relationships are easily understood which allows inherent vulnerability to be directly addressed. As complexity increases, the nature of the elements and their interactions within a system, become less well understood. A small change within or imposed upon the system can have profound, asymmetric and unexpected effects, increasing the system’s vulnerability to disruption and lowering its resilience to such disruption.

organisations share some common features that help them make better decisions that improve reliability and adaptability, particularly in fast moving, highly uncertain situations. These capabilities provide an improved ability to anticipate and make sense of change²³ and an improved capability to make and enact decisions under both routine and adverse conditions (Figure 11). Although adopting HRO principles on their own are unlikely to be sufficient for establishing high resilience (Tolk et al, 2015; Roe and Schulman, 2008), they nevertheless can make a useful contribution to improving resilience in conjunction with other attributes.

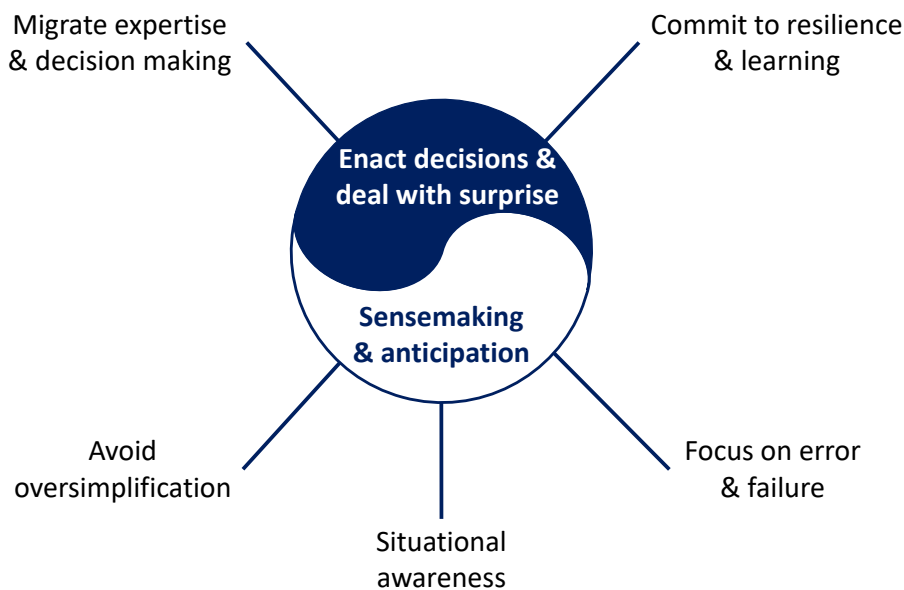


Figure 11: The high reliability organising model

Improved sensemaking and anticipation

High reliability organisations demonstrate highly effective sensemaking by:

- Continually updating current situational awareness and anticipating potential future change.
- Reducing hidden complexity and uncertainty through paying attention to and avoiding overly simplistic explanations of how the world (and their organisation) works.
- Paying attention to error and failure (monitoring and surveillance) to enable early warnings to be acted upon.

Situational awareness: High reliability organisations are constantly seeking to better understand their environment and their operations, in particular they endeavour to capture a deep understanding of the gap between formal operating landscapes²⁴ (work as ‘imagined’, ‘designed’, or ‘reported’) and

²³ Also referred to as organisational mindfulness (Vogus and Sutcliffe, 2012)

²⁴ In most organisations, there is a perception and belief about how functions operate (work as imagined). However, reality is often very different and there is often a big gap between those beliefs and what actually happens (work as done). This gap often occurs as a result of the normalisation of deviance (discussed in more detail later), a process by which unofficial shortcuts and other changed practices gradually accumulated to become an accepted norm. This gap in understanding has a range of ramifications: functions behave in unexpected ways; planned changes do not achieve expected results; controls and capability are less effective than expected; uncertainty and surprise are more frequently encountered.

informal operating system landscapes (work as performed). Improved sensemaking provides an understanding of what is happening now and helps anticipate what could happen in the future (Weick and Sutcliffe, 2015; Hopkins, 2002) – helping better informed decision-making.

A high reliability organisation invests heavily in ensuring that its people are on the lookout for the unusual. It is not possible for any one individual (or even an organisation) to be aware of everything, all of the time. However, HRO, through situational awareness and sensemaking, promotes those issues where vigilance is particularly important. This requires that organisational leadership develops an acute understanding about what is happening at the front line, whilst at the same time avoiding any temptation for micromanagement.

Equally important for sensemaking is ensuring that everyone in the organisation (and often key external stakeholders as well) understand where they fit within the ‘big picture’, emphasising the need for continual communication, and establishing a culture that supports such open communication. This also requires that individuals are capable of organising their own work in a way that builds situational awareness and sensemaking (and encourages them to do so). The incident command system is one example of where a formal structure can greatly assist in situational awareness, sensemaking and establishing a common operating picture (Bigley and Roberts, 2001).

Avoiding over simplification: Leadership needs to be aware of the complexity within their strategic and operating contexts, and understand that the natural tendency to simplify actually creates hidden complexity. It is out of such hidden complexity that future ‘surprises’ often emerge to threaten resilience. High reliability organisations avoid oversimplification, try to be suspicious of what appear to be simple explanations, learn to look beyond the obvious, and challenge assumptions.

Focusing on error and failure: High reliability organisations dedicate significant time and attention to recognising and thinking about error, and dealing with failures whilst they are still small. Part of this is cultural, viewing error as a learning and improvement opportunity, rather than something to be covered up or downplayed.

Improved capability to enact decisions

HRO recognises the difficulties in establishing comprehensive situational awareness and in anticipating future change. Therefore, there is a strong emphasis on being able to make effective decisions ‘in the moment’, being able to implement those decisions, and being able to learn from those decisions and actions. High reliability organisations achieve this through:

Migrating expertise and decision-making: High reliability organisations recognise that those towards the top of the hierarchy do not necessarily have the appropriate expertise or ability to lead and make decisions in all situations. As conditions change, the required expertise will be held by different individuals that may be at different levels within an organisation (Chassin and Loeb, 2013). HRO’s have leaders that understand this, know where the requisite expertise lies, and are willing to transfer across leadership and decision-making to the most appropriate individual. This has the effect of ‘pushing’ problem solving and decision-making down to the lowest practicable (capable) organisational level. Such situational leadership is an essential element of effective operation within a team, with team effectiveness determining how well HRO (Baker et al, 2006) and resilience will be realised.

Situational leadership starts in preparedness. People and teams are trained how to recognise developing disruptive conditions, and how to respond and react to those conditions. This kind of capability does not often occur naturally, but requires time and money to be spent on training people how to think and act in these situations, and providing time for them to practice these skills. It also

requires an empathetic leadership that avoids creating rigid hierarchies and allows decision-making to migrate down to those in the best position to make those decisions.

Committing to resilience and learning

A high reliability organisation develops over time using its experience of prior error, failure, what went well (and also what had no effect) to develop a 'corporate memory' and to use this learning to improve system capability and performance.

This commitment to resilience also involves understanding the ETTO principle (see previously) and balancing the tension between efficiency and reliability. For many non-HRO organisations, this balance is adversely shifted by inappropriate incentive systems that reward or force poor practices that provide short term returns, and discourage or punish more effective longer term practices (Alvesson and Spicer, 2017; Bircham and Connolly, 2013).

Ultimately, this 'commitment to resilience' involves leadership embracing the HRO principles and supporting and encouraging others in the organisation to do likewise. This can be operationalised through policies and procedures, budget and resourcing decisions, and by management behaviour. It may also require reorganisation, in particular developing new structures that enable the locations of relevant knowledge and expertise to make decisions and function cooperatively.

A modern aircraft carrier is a characteristic example of an HRO, particularly in its flight operations. Each of those different coloured shirts on the flight deck designates a different role, and a different type of expertise and decision-making authority, that is recognisable and accepted by the rest of the organisation. This allows a higher frequency of take-offs and landing than the busiest commercial airport, and on a 'runway' that is moving horizontally, and vertically, whilst pitching and yawing.

A cautionary note

The HRO concepts have been derived from organisations that consistently demonstrated high performance under potentially highly disruptive conditions. These same principles are also consistent with many of the contemporary ideas about resilience, and hence should be expected to contribute to overall resilience. The deliberate transformation to HRO capability has been demonstrated successfully for a number of small teams or parts of an organisation, for example, surgical teams in hospitals (DOD, 2017; Weaver et al 2014; Hines et al, 2008). However, attempts to deliberately engineer an entire organisation into an HRO have been problematic (Casler, 2014), and there may be limitations as to the size and complexity of a system to which HRO can be applied.

Resilience engineering models

The field of resilience engineering has focused on system safety, but provides concepts that are more widely applicable to resilience in general, and to organisational resilience specifically. Resilience engineering has indicated that there are four broad capabilities required for resilience (Hollnagel et al, 2011):

- Knowing what to expect – *anticipation*.
- Knowing what to look for – *monitoring*.
- Knowing what to do – *responding*.
- Knowing what happened – *learning*.

The Systemic Resilience (SyRes) model (Lundberg and Johansson, 2015) expands upon these capabilities:

i) Event based constraints: this represents the conditions and other contextual factors (such as organisational vulnerabilities²⁵) that the resilience system must cope with. This also includes how core goals and objectives are regarded, as under certain conditions the relative importance and priority of some of these goals and objectives may change.

ii) Functional dependencies: the functions deployed by a system in order to cope with events and their constraints. This comprises six functional dependencies:

- Anticipate the event - an early step that provides insight in to what could happen and thereby provides the targets for surveillance and monitoring. Anticipation requires an ability to foresight – an example of using ‘requisite imagination’ (Westrum, 2006).
- Surveillance and monitor for signals of developing conditions, based upon the insight gained through anticipation. A key organisational requirement is the ability to interpret these signals (Johansson and Lundberg, 2010).
- Respond by undertaking actions as a result of monitoring outputs, this may involve applying existing capability, implementing designed and prepared capability, or undertaking modification (adaptation) of capability.
- Recover which includes immediate relief and restoration as well as longer term repair, recovery, and rehabilitation.
- Learn, learning is essential to ongoing resilience (Comfort et al, 2010) and involves capturing and implementing the learning from anticipation, monitoring, responding and recovery.

iii) Adaptive capacity: the adjustment of capabilities (such as the functional dependencies above) to meet the needs of a developing situation.

iv) Strategy: the manner in which the resilience functions are approached, and involves consideration of one or a combination of:

- Avoidance: temporarily removing the system from the threat. For example, temporarily evacuating an exposed population.
- Immunisation: permanently separating the system away from the threat. For example, the permanent relocation and resettlement of a community.
- Control: attempts to control either the development of the threat, or its effects. For example, suppression of a fire with a sprinkler system.
- Rebuilding: repairing the system following the event.
- Knowledge: facilitating improvisation, learning, and informing and driving improvement.

Resilience Typology Model

Four different (often contradictory) broad concepts of resilience have been described (Woods, 2015; Lundberg and Johansson, 2015) that reflect an increasing maturity in conceptualisation:

- **Resilience 1** - resilience as rebound: the concept of rebounding or bouncing back to previous functionality following a disruption (see ‘curiosities and false starts’ previously). It has been suggested that these pre-existing (prior to the event) resources and capabilities may have more influence on this form of resilience than other resources and capabilities that are mobilised or acquired after a disruptive event (Finkel, 2011; Lagadec, 1993).
- **Resilience 2** - resilience as robustness: where a system is able to absorb the effects of perturbations. Whilst Woods (2015) distinguishes robustness and resilience as separate concepts, alternative arguments place it squarely within the resilience domain (Welsh, 2014).

²⁵ Note that some vulnerabilities may be present but latent during routine conditions, emerging as the system is placed under increasing stress by evolving non-routine conditions. Some vulnerabilities will also be created as a result of the effect of these changing conditions. Collectively these emergent vulnerabilities contribute to the system’s brittleness.

- **Resilience 3** - *resilience as graceful extensibility*: the ability to ‘stretch’ capability in response to disruption, such as in ‘extended business as usual’, and in doing so deal with any ‘brittleness’²⁶ in the systems involved.
- **Resilience 4** - *resilience as sustained adaptability*: where complex adaptive systems are seen as nested layered networks (Alderson and Doyle, 2010).

Attribute models of resilience

Attribute models describe resilience in terms of the attributes or characteristics that are believed to contribute to improved resilience. Such attribute models can only account for a small amount of the total factors that could contribute to resilience, whilst possession of these attributes themselves is no guarantee that a resilient outcome will be achieved. Some organisations demonstrate these attributes within a routine state, but can exhibit variable resilience under non-routine conditions. This may be a reflection of a combination of: vulnerabilities of these attributes that emerge under certain conditions, the relative appropriateness of these attributes and interactions across attributes under different and changing conditions.

Foundational attribute models

A range of different models postulate that resilience is built upon a number of dimensions or attributes (Cutter et al, 2010; Norris et al, 2008; Bruneau et al, 2003), including such attributes as:

- **Resistance**: a system’s ability to withstand the effects of stressors, without inducing any change within the system. This embraces the concept of ‘fault avoidance’, where the system elements are less likely to develop faults when placed under duress (Avizienis et al, 2004)
- **Robustness**²⁷: the ability of a system or its constituent elements, to cope with some degree of enforced change, without experiencing unacceptable deformation, degradation or loss of functionality. This embraces the concept of ‘fault tolerance’ where faults may be present, or develop under stress, but the system can cope with the effects of such faults (Avizienis et al, 2004).
- **Redundancy**: the ability to cope with a change induced impairment of a system or of its constituent elements, by employing additional or alternate capability.
- **Rapidity**: The ability to respond to a changing situation, and avoid failure, reduce impairment and harm, or recovery functionality in a timely manner.

Other (trait-based) models present resilience as a result of traits or behaviours by which individuals, teams or organisations operate (Harries et al, 2018; Burnard et al, 2018; Barasa et al, 2018; Patriarca et al, 2018; Hollnagel, 2018; Chmutina et al, 2016; Kaste et al, 2015; Schmidt et al, 2014; Zobel and Khansa, 2014; Akgün and Keskin, 2013; McCoy and Elwood, 2009; Nemeth, 2008). Whilst these traits and behaviours are seen as being complementary towards each other (Nemeth, 2008), depending upon how they are applied, traits can be both beneficial and harmful (usually deleterious when a behaviour is taken to extreme, or becomes inappropriate to a new developing context).

²⁶ The concept of brittleness concerns a system’s behaviour and performance as its routine operating boundaries are exceeded (Woods and Branlat, 2011). When boundaries are exceeded, system performance and integrity degrade suddenly and rapidly, as seen in highly optimised tolerance.

²⁷ Resistance and robustness are regarded as fragile approaches (Longstaff, 2005), being strategies that are effective over only a limited range of conditions (see earlier discussion on highly optimised tolerance).

A range of traits and behaviours have been associated with enhanced system resilience, including:

- Anticipation: expecting the unexpected.
- Challenging: preconceptions and assumptions.
- Being willing to take advantage of serendipity.
- Possessing trust and being willing to go beyond imposed obligations.
- Awareness: of limitation of available data and of the effects of cognitive and perceptual bias on sensemaking and decision-making.
- Using intuition, rather than relying solely on linear analytical thinking.
- Using innovative 'out of the box' thinking
- Using experimentation as a route to innovation, and recognising and accepting that experimentation means making errors and learning from them.

Evolving attribute model of resilience

These foundational trait models can be further expanded upon to develop an evolving common attribute model (Figure 12). This model recognises that various attributes may contribute to system resilience at different times during the 'lifecycle' of a disruption, and that the relative contribution of these attributes will vary as conditions change, and as a disruption evolves. For example, anticipative capabilities may be more important in the lead up to and in the early stages of a disruption. If a situation degrades into a significant disruption then adaptive and transformative capabilities are likely to be of more importance.

The model addresses the key attribute areas of:

- i) Anticipative capabilities for detecting changing conditions.
- ii) Proactive and preventive capabilities that modify the likelihood of a potentially disruptive event occurring.
- iii) Preparedness and protective capability that modifies the likelihood of the system actually being disrupted.
- iv) Responsive capabilities that modify the extent and severity of disruptive impacts on the system.
- v) Adaptive and transformative capabilities that modify the system's interaction with the disruption, and align the system with the changing environment.

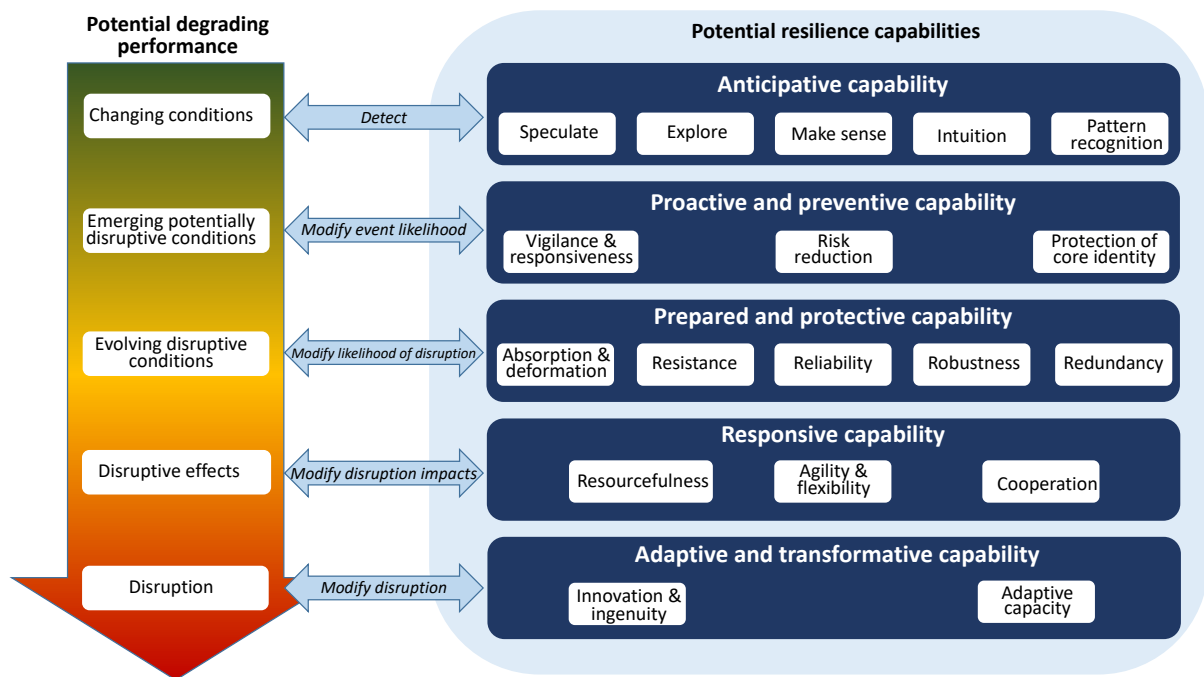


Figure 12: Resilience attribute model

i) Anticipate potential future disruption

The operating environment for most organisations is incredibly complex, there is usually significant uncertainty about what could happen in the long term, what might happen in the foreseeable future, and what could be happening right now that we cannot see.

The ability to make decisions and change current behaviour based upon forecast potential futures has been described as anticipatory behaviour (Poli, 2009). This is an inherent capability of the human mind and is regarded as a “core organising behaviour” of humans (Seligman et al, 2013). This capability features in the vast majority of day-to-day decisions and problem-solving that we all make. The human brain does not have the time or resources to access and review all learned experiences when making a decision, it takes short cuts ‘identifying’ those which are more likely to occur – it anticipates. However, anticipation does come with a cost (Seidl, 2014), and may misdirect attention.

Resilient systems interact differently with their environment as conditions change over time. More passive systems only change as the stressors affect the system’s functionality. Dynamic systems are more able to change earlier (during a disruption) or ahead of the disruptive effects. For a dynamic system to operate in this manner it requires the ability, at a minimum, for improved visibility, and for early detection of and sensemaking about changing conditions (Park et al, 2013; Craighead et al, 2007). More optimally, it requires the ability to anticipate the potential for disruptive conditions to develop in the future (Francis and Bekera, 2014). It is important to consider that resilience not only benefits from anticipation about what *events* may happen in the future (Woods et al, 2013), but also from anticipation about how the *system may react* to and cope with that future change and events. However, the impossibility of being able to anticipate and prevent all future adverse events also has to be recognised (Walker and Cooper, 2011).

The ability to anticipate is more than an abstract concept of predicting the future, and is regarded as different to traditional forecasting and prediction concepts (Nadin, 2015). Anticipating involves being able to foreshadow change by detecting early warning indicators of that change (Boyd, 2015 et al; Poli, 2014), and is regarded as a characteristic of ‘super-complex’ systems. This requires understanding

how a system's key elements interact and form interdependencies (both internal and external), in order to provide insight into how change in one area could affect change in other areas (Wildavsky, 1988). It has been suggested that multiple forms of anticipation exist (Hill, 2013; Wardekker et al, 2010; Nuttal, 2010; Riegler, 2001), that can all operate simultaneously and synergistically, but may at times be antagonistic to each other (Poli, 2010), and may change in importance over time. including:

- Explicit (conscious) and implicit (unconscious) anticipation.
- Anticipation that merely looks into the future, and anticipation that is making sense of that future and how it may impact upon the system.
- Temporal variants of anticipation, for example: micro-anticipation that occurs in a fraction of a second (e.g. that is embedded within perceptions) to social anticipation that forms over years.
- Anticipation that is focused inwardly within the system, and anticipation that is focused outwardly.
- Anticipation that is based upon different mechanisms (psychological, biological, social, etc.)

It has been argued that anticipation and resilience are separate, if not antagonistic concepts (Seidel, 2014; Wildavsky, 1998). However, this may be more a reflection of some authors' more narrow conception of resilience, or the belief that anticipation can only be effective where uncertainty is low. However, there is growing support for viewing anticipation as a foundation for resilience (Williams et al, 2017; Connelly et al, 2017; SmartResilience, 2016; Rahimi and Madni, 2014; Rogers, 2011, Tschakert and Dietrich, 2010; Conway, 2008; Hamel and Välikangas, 2003; Kendra and Wachtendorf, 2003; Rerup, 2001). Just as neuroscience has shown us how the brain anticipates and intuitively (through pattern recognition and building neuronal network linkages), so a resilient system is able to monitor for and detect patterns and anticipate how these may continue to change (Liu et al, 2013). There is a compelling argument for including a formal 'anticipation phase' in the development of resilience and disaster management arrangements (Yano et al, 2015; Rogers, 2011; Cabinet Office, 2005).

Anticipation has traditionally relied on techniques such as forecasting (using past experience and data to model plausible future scenarios), and foresighting (which creates models of the future using creativity rather than extrapolations from the past). However, the concept of anticipation is problematic. The environment in which most complex systems exist is characterised by novelty and the unexpected, where high levels of uncertainty are frequently present and encountered. Yet we cannot predict the nature of novelty that we may encounter in the future. The role of anticipation therefore becomes the search for tools that can be used to enhance our discovery and exploration of this novelty (Miller et al, 2013), particularly avoiding the common fear of error that can so readily inhibit anticipation. The role of sensemaking techniques is now coming to the fore in developing anticipation (Sandberg and Tsoukas, 2020; Klein, 2017; Rosness et al, 2017; Siegel and Schraagen, 2017; Maitlais and Christianson, 2014; Bartlett et al, 2013; Klein et al, 2007).

Anticipation plays a key role in facilitating effective surveillance and monitoring capability to detect changing conditions of interest (Figure 13). To establish a monitoring and surveillance system that is capable of scanning for an unknown range of potential signals of changing conditions within a myriad of 'noise' is an almost impossible task. We have to manage a balancing act, providing surveillance that is broad enough to capture the unexpected, but specific enough to be manageable and understandable. This requires an ability to anticipate broadly the areas of change that may require some future intervention or response, providing some guidance on where, when, and how to look.

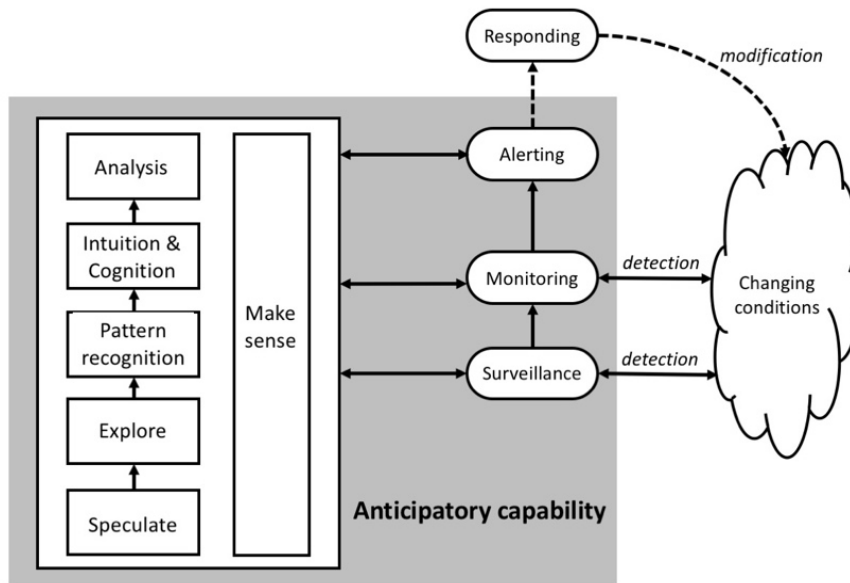


Figure 13: System anticipatory capability²⁸

Speculation

Speculation provides an important input into foresighting, it is a focus for anticipation, and in turn can help “guard against fragility” (Bland and Westlake, 2013). Speculation involves thinking about the range of potential futures, including:

- Probable futures – involving those things that are likely to happen, usually based upon an extrapolation of current conditions, state and options.
- Plausible futures – things that could happen based upon our current state of knowledge and our ability to link together ideas and patterns from multiple disciplines and observations.
- Possible futures – involves thinking about the wide range of things that could happen, beyond what is just probable or plausible.
- Preferable futures – a consideration of those things that we would like to happen, usually based more upon emotional rather than analytical considerations.

Effective speculation relies upon the knowledge of those participating, and their willingness to challenge assumptions and go beyond what is accepted thinking. Recent advances in crowdsourcing expert and lay opinion will substantially increase the ease of undertaking speculative activities and their value (Wazny, 2017; Merrit, 2016; Gubanov et al, 2014; Bozzon et al, 2013). Techniques from disciplines such as ‘speculative design’ and ‘creative disruptions’ (Resnick, 2011) can be applied to developing speculation about future potential disruption.

Exploration

There are a range of approaches available to expand upon and explore the outputs of speculative activities (GOS, 2017), the selection of which will depend upon the context within which the system is operating.

²⁸ Surveillance is a process by which signals of change are looked for continuously. Monitoring is a process by which specific signals (indicators) are watched, episodically, in order to detect change. Alerting is the process by which the identification of signals and indicators is communicated to others.

These approaches include tools for:

- Gathering intelligence about potential futures (such as: ‘horizon scanning’, ‘7 questions’, ‘issues paper’ and ‘Delphi’).
- Exploring change dynamics (such as: ‘driver mapping’, ‘axes of uncertainty’, etc.).
- Describing potential futures (such as: ‘scenario development’, ‘visioning’, etc.).

Making sense

A wide range of tools and techniques have been developed to aid both individual and shared sensemaking (Dennet, 2014; Paul 2010; Sharma, 2007; Soulier and Caussanel, 2002; Conklin, 2002), as well as red teaming; KSAO (‘knowledge’, ‘skills’, ‘abilities’, and ‘other attributes’) analysis (Damos and Weissmuller, 2011); experimentation (Ancona, 2011); narrative construction (Abofalia, 2010) and naturalistic decision-making (Gore et al, 2018; Klein, 2005).

Intuition and pattern recognition

A pure reliance on analytical thinking techniques and tools will not provide sufficient insight to support effective anticipation. The ability to make matches by comparing similar and dissimilar patterns in contextual signals provides the basis for intuitive reasoning on which meaningful anticipation relies. Our brains have a significant preference for information relayed as ‘stories’, and the ability to craft a narrative about the outputs of speculation and exploration supports pattern recognition and intuitive thinking.

i) Prepared and preventive capability

The ability to proactively deal with emerging issues, before they become problematic, can be a key determinant of resilience, and in addition to anticipative capability, is also commonly associated with a range of attributes, such as:

Vigilance and responsiveness

It is not sufficient to just be able to detect changing conditions, it is necessary that the system²⁹ is aware of the significance of those changes. The system must have capability to detect (surveillance), recognise (monitoring) and signal the detected change. This system (or other interdependent systems) must be able to understand (sensemaking) how the changing conditions could expose it to potential disruption. Following which, decisions and actions have to be taken in a timely manner (responsiveness).

Risk reduction

The management of risk can make an important contribution to promoting resilience, by reducing the likelihood and consequence of potentially disruptive conditions (Christensen, 2015). More importantly, when risk management goes beyond the constraints of standardised approaches (such as COSO and ISO31000), it can also provide a means of addressing high uncertainty and complexity, and improving decision-making under these conditions³⁰. However, there is a lack of robust published evidence that clearly demonstrates the extent of the real contribution of risk management to resilience. Conversely there is growing anecdotal commentary and published evidence that many traditional risk management approaches may add little of value, often fail to deliver, and in some circumstances may actually degrade resilience (Bostrom et al, 2020; Bryce et al, 2020; Golan et al,

²⁹ In reality the decision-makers and other actors within the system.

³⁰ To address the limitations of earlier standardised approaches Australia has developed a new Standard focussed on risk associated with high uncertainty, high consequence and low or unknown likelihood – *AS/NZS 5050: 2020 Managing disruption-related risk*. Other peak bodies, such as the Australian Risk Policy Institute have also developed alternate approaches to deal with the uncertainty associated with systemic risk and vulnerability, and the relationship of risk to resilience .

2020; Horton, 2020; Ker, 2020; Kunreuther and Slovic, 2020; Menoni and Schwarze, 2020; Pegram, 2020; Richardson, 2020; Sharma, 2020; Trexler, 2020; APRA, 2018; Hodge, 2019; Stultz, 2008).

Protection of core identity

Ultimately, for a system to undergo change or transformation and still remain resilient, it must protect its core identity. Core identity is expressed by a system's purpose, objectives and values, against which all of its activities should be aligned. Successful systems are capable of modifying their intent and objectives to better align with changing conditions, even though the 'core identity' remains protected, for example by:

- Preventing and protecting the system from what may be minor perturbations, but that could have the potential to escalate to disruptive conditions if unattended. A resilient system focusses not just on the prospect of disruption but also on the minor perturbations that occur through business as usual (BAU) activities, i.e. resilience involves dealing with both the expected and the unexpected change (Hollnagel et al, 2011). For example, this could include extending business-as-usual capability, proactive risk treatment, etc.
- Avoidance, where actions are taken to avoid exposure to potentially harmful conditions. For example, an emergency response team that is able to detect, make decisions and evacuate from an increasingly dangerous location, is likely to be more resilient than another team that remains *in situ* and relies on their equipment to protect themselves (Schmid and Pawlowsky, 2018).

A resilient organisation will adopt new and innovative ways of protecting (and achieving) its core identity, particularly when they are challenged by unwanted and unplanned change. Over time, there may be a need to adjust these objectives and values to align the organisation with a new direction in which it may wish to proceed.

ii) Prepared and protective

Whilst potentially disruptive conditions should be prevented from occurring, this may not always be possible or practical. A highly resilient system is prepared for any disruption that could arise, is able to respond in the initial stages to reduce disruptive consequences, and if necessary recover from disruption. Preparation does not just involve building an emergency or contingent capability, but also needs to consider strengthening the organisation to deal with the adverse effects of such a situation. Preparation allows a range of different capabilities to be developed, which are effective at different levels of complexity and adverse change (Figure 14).

For example, system reliability would be expected to operate only over a narrow range of change and complexity. Once these thresholds are exceeded, then capabilities associated with resistance are expected to become more important to continuing system performance. If the conditions facing the system continue to degrade, the thresholds for resistance are in turn likely to be exceeded, and so on with different capabilities. This does not necessarily mean that there will be a linear sequence of activation and failure of these capabilities as they are progressively overwhelmed, rather it is the relative importance of their contribution to resilience that differs as a disruption evolves.

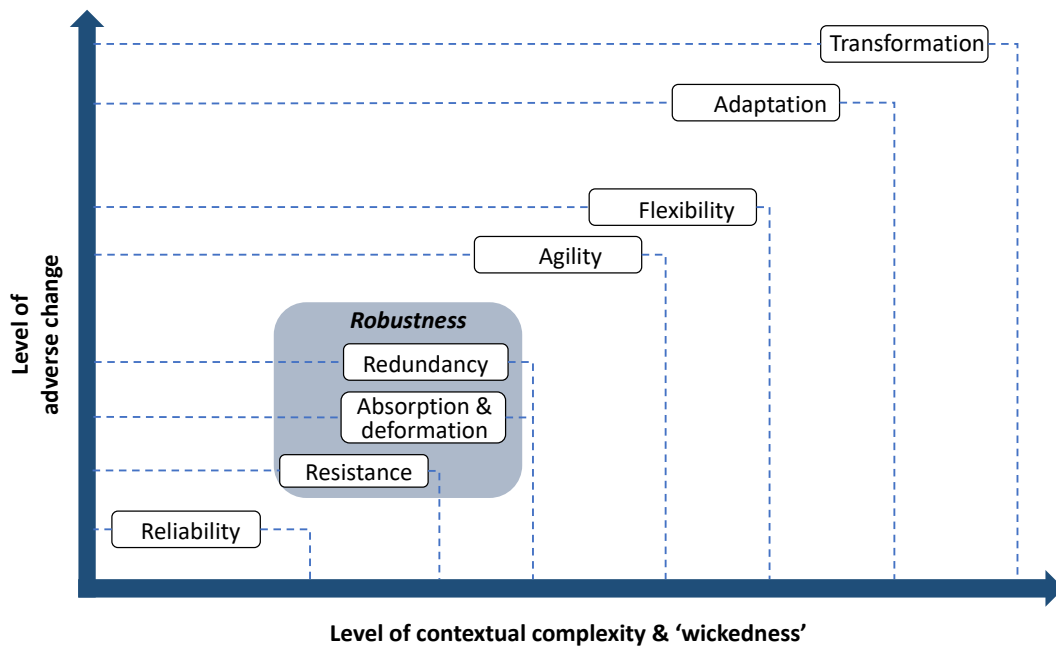


Figure 14: Key capabilities contributing to resilience
 (dotted lines represent thresholds beyond which these capabilities are overwhelmed)

Reliability/Resistance/ Robustness

A reliable system provides expected levels of performance under the routine operating conditions for which it has been designed (Shinozuka et al, 2004; Kundzewicz and Kindler, 1995), and remains undisrupted by the normal day-to-day perturbations which it experiences. A reliable system should be better able to operate over a larger range of threshold conditions compared to a less reliable system.

Resistance allows a system to withstand the immediate and more prolonged effect of stressors (Handmer and Dovers, 2009). It represents the ability to withstand stressors without physical or functional deformation or other effects on the system, and has been regarded as an expression of the system's error tolerance (Cuesta et al, 2016).

Robustness has at times been distinguished from resilience (Fath et al, 2015; Mitchel, 2007), whilst other authors have regarded it as an important attribute of a resilient system (Panteli and Mancarella, 2015; De Bruijne et al, 2010; Asbjørnslet, 2008). Robustness is generally used to describe a system's ability to continue to provide an acceptable level of functionality under exposure to increasing levels of stress, although some level of system impairment may be experienced. This could occur as a result of the system's resistance, or its ability to absorb and deform on exposure to disruptive change, although most strategies aimed at improving robustness try to address system vulnerabilities (Aven, 2015).

Absorption and deformation

One attribute of a resilient system is the ability to absorb the effects of disturbance and disruption, and still remain within acceptable thresholds of functionality (Renschler et al, 2010), even though the system has undergone some form of deformation and degraded capability. The ability to absorb and deform to deal with the effects of a disruptive event, often stems from the design and development of the system, and as a consequence is usually an inherent or automatic response to disruptive

conditions. As this is typically a feature of a highly optimised tolerant system, it will be effective only over a very narrow range of conditions, hence such capability can be rapidly overwhelmed.

Redundancy

Redundancy (along with flexibility) has been identified as a key contributor to resilience (Rice and Canatio, 2003). Redundancy is capability that is generally not used during BAU operations, and may comprise, people and skills, systems, infrastructure and other assets, processing capacity, inventory, financial reserves (Australian Government, 2012), etc. Redundancy is often acquired by exploiting formal and informal networks (Weick and Sutcliffe, 2007), and is usually achieved through one or a combination of:

- Restart/recalibrate: having the capability to bring the effected system, process equipment, etc. back on line before disruptive effects manifest.
- Back-up: having 'spare' or 'retired' capacity (that is mothballed or sits idle until needed), or reserve or duplicate capability (such as 'surge capacity' which is available to cope with excessive workload demands).
- Diversion: diverting or reallocating required capacity from other lower priority activities, or from areas where the capacity is being under-utilised.
- Substitution: replacing the effected capability, with alternate (often suboptimal) capability.
- Variation: 'unusual' resources and capabilities are used in a different and unique ways to achieve the required outcomes.
- Cross checking: information redundancy involving detection and correction of error.
- Multi-modular: several identical system elements, usually operating in parallel, any of which are capable of undertaking the required tasks at any time, should any of the other system elements fail.

Conversely, too much redundancy in a system can be highly problematic, it can be expensive, and it is often difficult to argue the case for maintaining unused capacity – 'just in case'. Redundant capability can also 'age', where over time it becomes less able to fulfil its required function, representing a substantial loss of investment. This can be particularly problematic where there continues to be a mistaken belief that the redundant capability remains fully functional, when in reality it can no longer be relied upon. In addition to the obvious cost implications, an excess of redundancy can increase system complexity, to the extent that its operation becomes highly uncertain and unpredictable (Perrow, 1984). Indeed, some forms of redundancy, and its associated complexity, can itself contribute to lowered resilience and system failure (Leveson, 2001).

iii) Responsive capability

Resourcefulness

Resourcefulness is demonstrated by using or combining existing resources and capabilities in new ways. A resourceful system is able to step beyond its routine operation and demonstrate new abilities to detect changing conditions, identify and understand emerging problems, and find and then deploy the resources to implement innovative solutions to resolve those problems (McLeod, 2017; Ayala and Manzano, 2014; Mackinnon and Driscoll Derickson, 2013; O'Rourke, 2007; Tierney, 2003; Bruneau et al, 2003; Kendra and Wachtendorf, 2003). Resourcefulness is often an expression of the system's agility, flexibility and adaptability.

Agility and flexibility

The two terms agility and flexibility are often used interchangeably, or are spoken of together with little actual consideration of what they really mean. Agility is the ability of a system to respond easily 'on the fly', to unplanned or unanticipated change in an appropriate and rapid manner, particularly

where substantial time pressures exist (Farrell et al, 2013; Spaans et al, 2009; Christopher and Peck, 2004). Some authors regard flexibility as more of a planned ability to respond differently to unanticipated change, (Goranson, 1999; Johansson and Pearce, 2014). Both flexibility and agility make important contributions to resilience (Sheffi, 2005), and as conditions become subject to more rapid change, the importance of agility and flexibility increase (Azusa and Hiroyuki, 2013). From the perspective of organisational resilience, leadership agility and flexibility assume a prime importance (NATO, 2013; Alberts, 2011).

It should be remembered, that agility is really just an artefact of a system, it is created by a range of competencies and processes. For example, agility is generated by how well people make sense of their changing environments, the speed and appropriateness of the decisions they make, the way that they implement these decisions, their ability to change their behaviours, and perform their tasks as conditions change (Dyer and Schafer, 2003). It has also been proposed that agility is generated through:

- Being proactive, by:
 - initiating action by searching for opportunities,
 - improvising by creating new approaches to pursue these opportunities.
- Being adaptive, by:
 - assuming multiple roles that cross different levels of the hierarchy and that cross organisational boundaries,
 - being able to move quickly from different role to role,
 - collaborating spontaneously with others, then rapidly disengaging when that collaboration is no longer required.
- Being generative, by:
 - continuous learning within multiple different areas of competency,
 - helping in the education of others by sharing knowledge.

However, any agility generated by an individual's efforts can be greatly compromised by the rigidity of established organisational culture, and by unnecessarily inflexible and imposed systems of work (as often occurs when business continuity is applied with little understanding or thought).

Many organisations have adopted practices from Agile project management, and applied them more broadly to improve overall strategic and operational agility. It has been suggested that management practices such as 'Lean' and 'Agile' can provide important contributions to resilience when expanded from their traditional 'homes' (such as project management and manufacturing) into other areas of organisational management (Adamides and Voutsina, 2006).

On a cautionary note, creating system agility can also lead to an increase in system fragility in some circumstances. For example, some HR practices aimed at increasing agility have included flattening management structures (by removing layers of skilled middle managers), downsizing and removing entire jobs and functions, whilst distributing workload and diluting skills through broadening the scope of many of the remaining roles (Heifetz et al, 2009a; Pal and Pantaleo, 2005; Dyer and Singh, 1998). Whilst such action can improve agility (and lower costs) by reducing decision-making and implementation time, they can also reduce flexibility (by limiting capability and options), diminish surge capacity, inhibit complex problem solving capability, and act as barriers to innovation and adaptation.

Adversity and opportunity

It is important to remember that a resilient system is not just able to respond to disruption and adversity, it must also be capable of effectively capitalising on opportunities (Burnard and Bhamra,

2011). For example, consider the sudden financial collapse of the Australian commercial airline, Ansett Group in 2001 (Leiper, 2010; Lockhart and Taitoko, 2005; Forsyth, 2002). The sudden and urgent demands from an immediate influx of substantial numbers of stranded passengers seeking flights proved a challenge to the short-term resilience of other airlines flying the same routes.

iv) Adaptive and transformative capability

Innovation and ingenuity

Disruption is often characterised by the presence of so-called ‘wicked problems’³¹ which require innovation and ingenuity that goes beyond routine thinking to solve (Craig, 2020; Termeer et al, 2019; Colding et al, 2019; Waddock et al, 2015; Duijnhoven and Neef, 2015; Ferlie et al, 2013). Resilient systems demonstrate novel ways of dealing with these wicked problems that arise from changing conditions, through applying additional resources and effort, introducing new capability, or adapting existing capability.

Adaptive capacity

Adaptive capacity is a property that allows the system to adjust its nature in response to changing internal demands and external drivers and constraints (Carpenter and Brock, 2008). In particular where a modified, or additional capability is developed to deal with the effects of disruption and maintain continuing functionality.

Some adaptive capacity will arise through ingenuity and innovation. Some adaptive capacity will arise through ‘emergence’, a property of complex adaptive systems. Emergence describes how new abilities can arise from the interaction of the components of a complex system, something greater than the sum of the system’s parts (De Florio, 2016).

Transformation

Adaptive change is often viewed as modifying the system to better cope with a new environment (maintaining the ‘regime’). However, transformation is more than adaptive change, it is about creating a new system (‘regime change’) that better ‘fits’ with this changed environment (Moore et al, 2018; O’Connell et al, 2015; Olsson et al, 2014; Gilbert et al, 2012). Transformative capability has been associated with a distributed transformative agency, i.e. leadership for transformation does not rest with one single powerful leader, but is rather distributed throughout the system. As transformation progresses, individuals may have different roles at different times (Burnes et al, 2016; Westley et al, 2013; Lawrence et al, 2011).

Complex adaptive systems and resilience

Most organisations and communities are complex adaptive systems, that themselves comprise lower order complex adaptive systems. The very nature of such systems has profound implications for understanding and assessing resilience.

³¹ Wicked problems are characterised by: non-linear nature; arise from interaction of other wicked problems, difficult to describe the problem; simple solutions do not work to resolve the problem; information about the problem and its solution is fragmentary; resolution of the problem usually requires knowledge from a range of disciplines; different stakeholders are often required to solve a wicked problem, but commonly have conflicting interests. Solving wicked problems require different approaches to routine mechanisms such as simplistic business continuity and risk management plans.

Complex adaptive systems are capable of performing over a wide range of potentially disruptive conditions and demonstrate a number of common properties (Ellis and Herbert, 2011; Martin and Sunley, 2007), including:

- ‘Open systems’ with continual flows into and out of these systems (e.g. the exchange of information, resources, and energy), all of which can experience sudden fluctuations. In sociotechnical systems, this commonly occurs through the continuous interaction of humans.
- Self-organise and operate at multiple scales or levels.
- Comprise multiple different components and subcomponents, often with multiple non-linear dynamics, which are usually adaptive, irreversible and path-dependent. This can cause system behavior and state to shift rapidly, for example from highly stable to highly unstable, without a predictable progression.
- Behaviour of the system as a whole emerges from the constant multiple interactions of its subcomponents or actors (Holland, 1999; 1992). This emergent behavior is more than just the aggregation of behaviours at the component level. The nature of these interactions generally depend upon the nature of previous interactions and hence are commonly unplanned, spontaneous, and difficult to predict, in a way that defies simple cause-and-effect thinking.
- This behaviour can be asymmetric or ‘chaotic’, small changes in the system can result in large (and unpredictable) changes and outcomes, and conversely large changes can have minor outcomes (but not always). The past behaviour of a complex adaptive system does not always provide an accurate indicator of future behaviour, even when conditions are similar (Duit et al, 2010).

It is therefore almost impossible to deduce or predict future resilience based upon analysis and measurement of the functionality of separate subcomponents of a complex adaptive system under routine stable conditions (Carlisle and McMillan, 2017; Justice et al, 2016; Health Foundation, 2010; Guastello and Liebovitch, 2009; Surana et al, 2005; McDaniel et al, 2003; Begun, 2002; Waldrop, 1994).

Resilience only emerges and becomes apparent when these complex adaptive systems are placed under stress (Albani and Kupers, 2014). However, increasing exposure to stressors, such as disruptive conditions, can adversely affect adaptive capacity, progressively degrading this capability. The stressors can eventually overwhelm the system, unless additional adaptive capacity is released, developed, or acquired (McCann, 2004). Resilience in a complex adaptive system is, therefore, highly dependent upon adaptive capacity that is able to function under a wide variety of changing conditions and stressors.

It is important that this adaptive capacity and its outputs remain aligned to the system’s purpose and objectives. Under conditions of significant change, objectives can become rapidly obsolete or irrelevant to the new emerging context. Adaptation therefore not only needs to consider how the system’s functionality, processes, capabilities, etc. can adapt, but must also address the need to adapt the purpose and objectives to better fit the ‘new normal’ that the system now has to operate within.

It is equally important that the ‘resilience objectives’ also continue to be aligned to the system’s evolving purpose and needs. Should any misalignment occur, this could further reduce resilience.

Resilience in complex adaptive systems is not just about adaptation to challenge in the moment, but involves continuing iterative and cyclical adaptive processes. Adaptation involves continuing challenges, trialing innovative solutions to those challenges, learning from successes and errors of that innovation, and using that learning to adapt and transform the system (Figure 15).

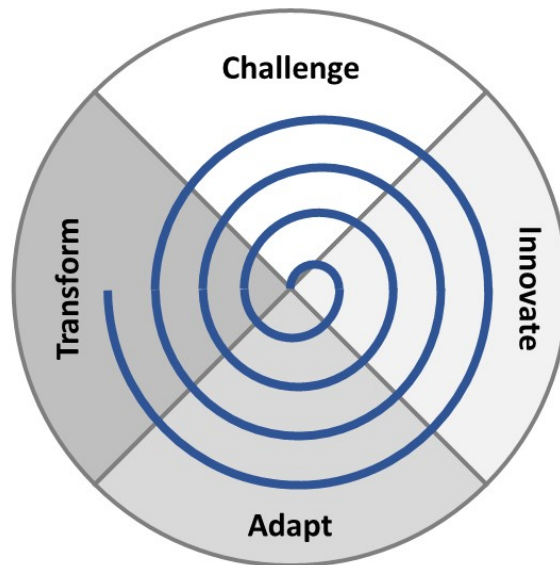


Figure 15: Resilience transformation cycle
(the starting point is with the challenge in the centre of the spiral)

It has been argued that rather than building resilience per se, complex adaptive systems work to prevent or remove constraints and barriers that would otherwise disrupt the innovation/adaptation life cycle. These barriers are created by the decisions we make, and the types of structures, processes and competencies we choose to put in place (Westley, 2013). Thus, identifying and dealing with these barriers and constraints (vulnerabilities) can provide a potent promoter for resilience.

Cybernetics and resilience

Cybernetics is the science and study of ‘control’ of a system. In the simplest of systems there will be a controlling process and a process being controlled (Brehmer and Allard, 1991). In ‘resilience’ we are interested in systems that can undergo planned and unplanned change over time (with or without external influence), so called dynamic systems (Pérez Ríos, 2010; Scheffer, 2009; Ackoff, 1971). Control of a dynamic system involves steering the behaviour of the key elements of that system.

To be effective, the controlling process/system needs to possess as much (or more) behavioural diversity as the controlled process/system. Accordingly, the agility and adaptability of a system, should be matched by the agility and adaptability of the system controlling it. In real world terms, if we modify a system, such as ‘customer service’ then the systems controlling ‘customer service’ (‘staff training’, ‘reward and recognition’, ‘governance’, ‘supervision’ ‘compliance’, etc.) will also require modification. This has significant implications for attempts at improving resilience, as a focus on improving one organisational system, without considering other interacting systems, often results in unexpectedly lower capability and performance. This further illustrates the nonsense of trying to measure or build resilience in a component by component fashion, separated from how the system as a whole operates.

Learning and change

Resilient systems demonstrate the ability to learn from prior experience and apply that learning to addressing vulnerabilities, better managing risk, and further improving preparedness. Resilience is not just about learning, it is about *learning the right things*, at the *right time*, including learning from both what goes well and what does not go well (or even what decisions or actions made no difference at

all). Learning helps create opportunities to be exploited, drives innovation and builds resilience (Zolli and Healy, 2013), and it still holds true that “if an organisation does not learn from crises it will remain crisis-prone” (Pollock, 2016)

Effective learning requires an acceptance and understanding of the need to learn, and a willingness to learn (Lundberg et al, 2012; Farrell and Connell, 2010). Learning contributes directly to many of the acknowledged resilience attributes. It enhances the breadth and depth of anticipation and sensemaking, increases the diversity of capability that can be applied to prevent, respond to, and recover from disruptive change, and increases the range of available adaptive options that can be pursued. However, organisational learning can be fragile and susceptible to the barriers created by the various power relationships and ethical constraints that are often present.

Understanding the operation of feedback mechanisms is important in establishing organisational learning (Willis, 2014; Le et al, 2012; Sterman, 2001). A number of different types of feedback loops (Figure 16) have been described (Loverde, 2005).

- Single loop learning provides a means of modifying decisions or actions based upon the detected system outputs, where the focus is on running the process correctly. This is *reactive* learning, and is essentially backwards looking.
- Double loop learning is based on reflection about the outcome and reframing of the intent and objectives. This form of learning is concerned with not just doing the ‘thing right’ but ‘doing the right thing’. This is deliberative learning and is also essentially backwards looking.
- Triple loop learning questions whether we have an appropriate understanding of the context that we operate in, in order to know what is the right thing that has to be done, and that we can then do things differently. This is reflective learning and is principally forward looking.
- Quadruple loop learning is far more philosophical and deeply reflective in nature and aims to surface and challenge foundational beliefs and assumptions, and justify rationales.

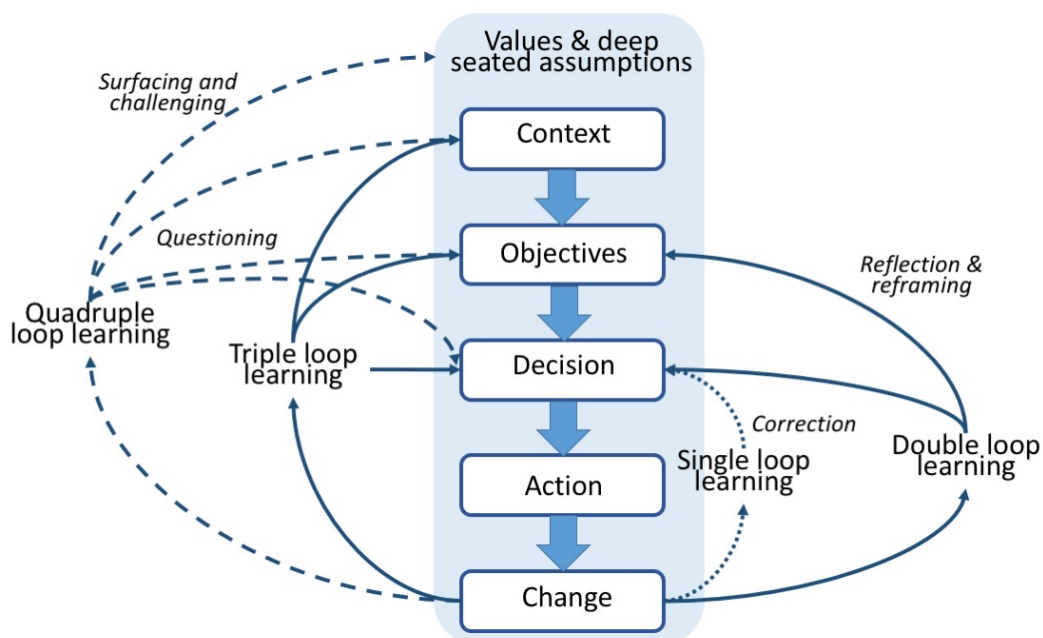


Figure 16: Organisational learning loops

Cooperation

Cooperation within and between systems has been strongly associated with improving resilience (Wyss et al, 2014; Lamond and Proverbs, 2009). Organisations that are strongly founded upon cooperative principles (such as social and worker cooperatives) demonstrate particularly strong resilience (Roelants et al, 2012). Developing resilience requires a culture that fosters cooperation and social innovation (Westley, 2013), for example a culture that encourages communication and allows disparate groups and people to “meet and mingle”. This is further enhanced where a strong sense of identity, purpose, and beliefs exists (Freeman et al, 2004; Coutu, 2002).

Networks and interdependencies

Understanding interdependencies and the networks³² formed by these interdependencies is a fundamental requirement for understanding resilience. Interdependencies will exist across and between systems and within systems (across and between the various elements that comprise each system). The nature of these interdependencies within the networks that they form will have a direct effect on system vulnerability, fragility and on resilience. For example, in Figure 17 the nodes in network A have only linear sequential dependencies, and the achievement of the two end points is wholly dependent upon all nodes and connections functioning as designed. Whereas for network B, there are multiple interconnections between nodes, allowing multiple alternate paths to be followed if any specific node or connection is compromised. A number of interdependency factors need to be considered within any networks:

- The importance of key network elements (i.e. nodes)
- The number and importance of dependent relationships (the connections between the nodes).
- The strength and fragility of specific nodes and connections.
- The presence of alternate connections and pathways between the nodes.

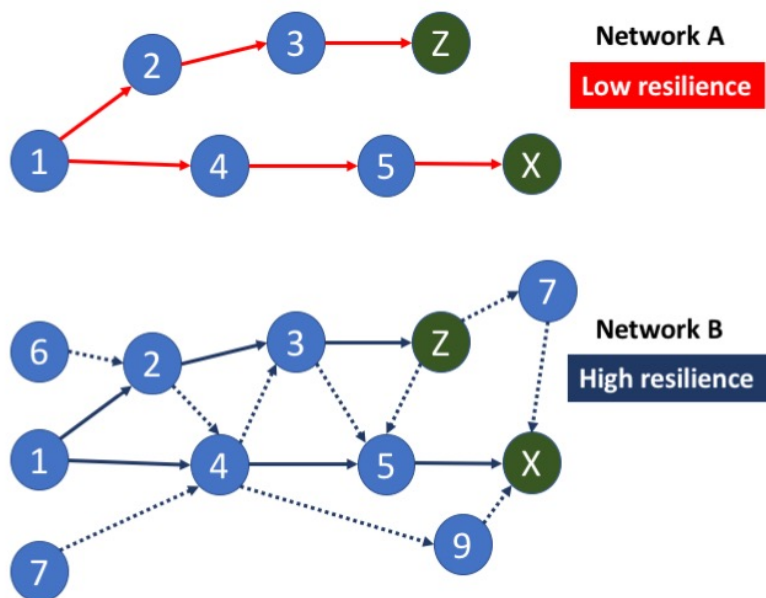


Figure 17: Network resilience

³² The concepts of networks includes any collection of interdependent elements which may include infrastructure and other assets, functions and processes, data and information, people, goods and services, consumables, etc.

However, many highly complex networks often demonstrate low resilience, because one or more nodes have a high criticality (Moutsinas and Guo, 2020; ENISA, 2011), for example many interconnections pass through that node (high degree centrality) or the node presents the only available pathway to a critical flow. Should a critical node be compromised, fragmentation and failure of the network occurs (Chopra et al, 2016; Falasca et al, 2008). One of the major problems of highly complex systems is that the networks within these systems are often poorly understood, and the presence of critical nodes is not identified until a catastrophic system failure occurs. Whilst sectors such as transport, water and power often have high level appreciation of their distribution infrastructure networks (Meng et al, 2018), this level of understanding is uncommon in other operating, information, decision-making and supply chain networks within these and other organisations generally (Pourhejazy et al, 2017)

Practical implications of resilience

Overview of Organisational Resilience

Organisations co-evolve with their changing external environments (Dosi and Marengo, 2007). When the environment is relatively stable, the rate of change is relatively slow and progressive (and comparatively easy to predict), and so organisations are generally able to purposefully change to align with this type of evolving environment. However, in volatile environments, when change is unexpected, sudden and dramatic, it can easily overwhelm an organisation's capabilities to cope. A wide range of different types of internal and external change will have a strong influence upon organisational capabilities (Valikangas, 2010). This is of particular concern when these are the very capabilities required for managing disruptive conditions.

Under such conditions, an organisation may experience some form of failure, from disruption to catastrophic collapse, whilst other organisations continue to operate successfully (Fiksel, 2015). The concept of organisational resilience offers an attractive and plausible prospect for an organisation faced with unplanned change and potential disruption. However, it certainly appears that many organisations are experiencing a 'resilience gap' where the increasing rate of turbulence is outpacing the ability of organisations to become resilient (Hamel and Valikangas, 2003). Conversely, some resilient organisations have demonstrated an ability to influence and "shape" their external environment (Geels, 2014; Kay and Goldspink, 2012).

Some authors have suggested that, in the face of significant uncertainty, it would be more effective investing in 'resilience' than in managing risk (Park et al, 2011; Wildavsky, 1988). It is likely that these reviews reflect a more limited perspective on risk and risk management, and of course presupposes that reducing uncertainty and modifying risk does not contribute to resilience (whereas we would argue that modifying risk most definitely can contribute to resilience).

Organisational resilience is only ever a provisional concept, it will always and totally depend upon what happens in the moment, as the complex interactions of the multiple parts of an organisation³³ 'respond' collectively to a stressor (Lissack and Letiche, 2002). Consciously building resilience is

³³ Where these multiple organizational parts may include people systems (psychological, behavioural, cognitive, etc.), structural systems (hierarchy, empowerment, power relationships, information flows, etc.), procedural systems, etc. (Schmidt et al, 2014; Kimberlin et al, 2011; Coutu, 2011; Weick and Sutcliffe, 2007; Masten, 2001; Horne and Orr, 1998).

problematic, there is no single magical silver bullet solution (Birkie et al, 2014), and there continues to be a lack of certainty over what actually contributes to organisational resilience.

Many of the factors that other authors have implicated in resilience are also those same factors that have been identified for successful BAU day-to-day performance and strategic success. Yet even the importance of these routine management factors has been heavily debated (NIST, 2017; Tucker et al, 2013; Westerveld, 2003; Fernandez and Rainey, 2006; Pinto and Slevin, 1988). It is no surprise then that consensus has not been reached on what definitively 'makes' organisational resilience. This also begs the question – *is there any difference between resilience and just good management?* The difference may be simply down to the ability of these routine success factors to still be available and functional under increasingly disruptive conditions.

Certainly, organisational resilience appears to be as much a result of the prevalent attitudes as it is about the discernible 'capabilities' that the organisation can utilise (Kendra and Wachtendorf, 2003). This includes the ability of individuals and groups to engage in shared sensemaking about rapidly changing, uncertain and ambiguous situations (Weick, 1993). In this respect 'sensemaking encompasses:

- The concepts of 'bricolage' (creative improvisation).
- The ability to establish 'virtual role systems', which involves conceptualising the system as a whole and the roles of others within that system, and then individuals aligning their own actions to the shared goals of the group.
- The ability to apply 'wisdom' both to challenge assumptions, and to seek out different information and understanding.
- Engaging in 'respectful interaction', including trusting others and acting upon their advice, and being open and honest in dealing with others.

It must always be remembered that organisational resilience is not about managing a specific event, but is about building a capability to deal with the effects of a wide range of different conditions (reinforcing the all hazards approach). Ultimately this comes down to a question of economics, to what extent can the organisation afford to be 'resilient'?

Daily life within any organisation is driven by the availability of sufficient funds. Funding is a scarce resource and trade-off decisions are made constantly, where the attractiveness of delivering short-term performance usually wins out (Bircham and Connolly, 2013). It is often difficult to argue for resilience when the benefits may be years or decades away, but efficiency gains can be almost immediate.

Organisational resilience: developing resilient capability

As with general systems' resilience, an organisation can only be judged as 'highly resilient' in hindsight following a disruptive challenge, and then only in relation to that *specific* event. We may however, be able to say that an organisation possesses some attributes that could contribute to a *potential capability* for resilience to future events. These various attributes neither guarantee resilience, nor is their presence an actual measure of an organisation's resilience. Such capabilities can however, contribute to driving and enabling an organisation's *potential resilience*³⁴, the relative importance of that contribution being dependent upon the nature of the challenge being faced.

³⁴ They have also been referred to as 'resilience potentials' (Hollnagel, 2017).

The general resilience models (discussed previously) provide some insight into the nature of a range of attributes that deliver robustness, redundancy, resourcefulness, agility and adaptability (Zhong et al, 2014). In domains such as organisational, community and critical infrastructure resilience, a range of other attributes also need to be considered (see below). Any meaningful model needs to be able to present organisational resilience in terms of:

- What is resilient – for example: a whole organisation, specific elements of the organisation (parts, locations, structure, functions, services, teams, etc.).
- To what challenges or stressors is the organisation resilient.
- What is the purpose and outcome of this resilience – why is this resilience necessary and how is this resilience shown.

Different levels of organisational resilience may be desirable at different times, and under different conditions (Limnios et al, 2014). For example, lower levels of resilience may be more desirable when the costs of maintaining higher resilience-related capability outweigh the benefits under anticipated conditions of low levels of ongoing disruption.

It should be remembered that where an organisation has a particular focus on strengthening one particular aspect of resilience (such as robustness), there may be a trade-off (Hoffman and Woods, 2011; Alderson and Doyle, 2010) resulting in increasing brittleness or fragility in other aspects (such as reduced speed of response, or lowered agility).

Drivers of potential resilience

For convenience, the attributes contributing towards organisational resilience can be regarded as either drivers or enablers of resilience, and include a diverse range of human-related attributes (Figure 18). Drivers provide the foundation and direction for the development of resilience capability, whilst enablers help to create a favourable environment within which the drivers can function. Also of consideration are the supporting mechanisms such as physical and logical infrastructure, and knowledge which are outside of the scope of this diagram. It is important to remember that, like all other resilience constructs and models, drivers and enablers are artificial categorisations to help explain some of the complexity that is embodied within resilience.

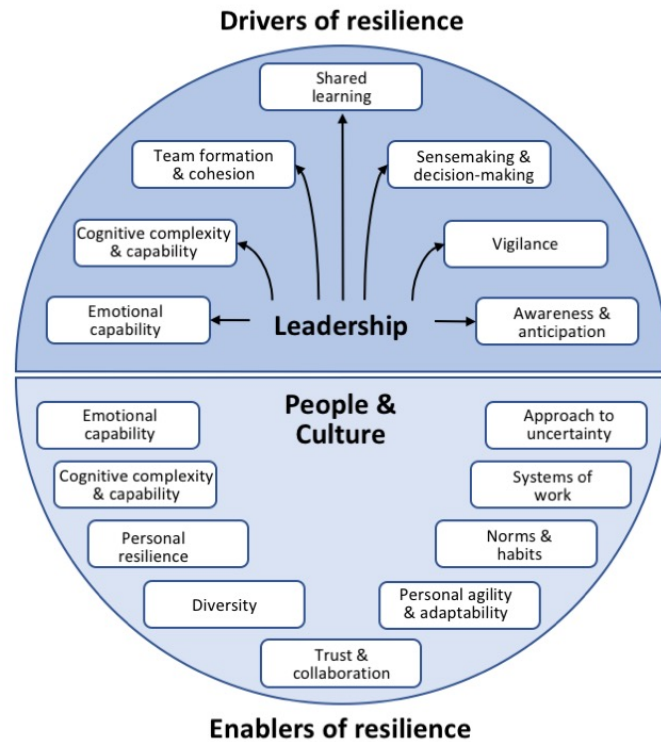


Figure 18: Human-related drivers and enablers of organisational resilience

Leadership

Effective leadership drives the establishment of organisational factors such as:

- Explaining the organisation’s purpose, and orientating the organisation towards that purpose (Bohn and Grafton, 2002).
- Ensuring that the requirements for resilience are clearly understood and are justified within the organisation’s strategic and operational imperatives.
- Effective anticipation and effective planning strategies (Tadić et al, 2014).
- Encouraging collaboration.
- Facilitating experimentation, accepting that errors will be made, and being comfortable enough to make mistakes (Heifetz et al, 2009b).
- Establishing the importance of narrative to build awareness, understanding, and shared sensemaking within the organisation (Wilding, 2017).
- Establishing individual, team and organisational learning (Dickens, 2015).

An absence of effective leadership has been blamed for the inadequate response to disaster (Waugh, 2009), whilst the ability to motivate and communicate ‘purpose’ has been associated with effective emergency response (Stern, 2013; Van Wart and Kapucu, 2011; Sjoberg et al, 2011). Effective leadership is essential to BAU performance of an organisation, in a stable and predictable environment, and for contributing to resilience when faced with disruptive conditions. However different aspects of leadership and different leaders may be required in non-routine compared with routine conditions.

Leadership sets the 'tone'³⁵ of the organisation including emotional tone³⁶, largely determines how individuals and teams respond to the challenges and disruption they face, and is a major determinant of the overall organisational culture (Drury, 2013; Drew, 2009).

Whilst some leadership attributes may be similar in routine and non-routine operation, how these attributes are practised may need to be different if an organisation is to prove resilient. For example, the leadership role under disruptive conditions will of necessity need to be more immediate and intense in directing the organisation. This requires a greater emphasis on ensuring that decision-making is knowledge-based and made by those with visibility of the problem. Decision-making needs to be supported by decision tools and techniques appropriate to the volatility, novelty, uncertainty, complexity and ambiguity that is being faced (Schwaninger and Pérez Ríos, 2008). Certainly, formal knowledge management provides significant performance advantages (Chourides et al, 2003), and with the support of technology, for example, can provide information and insight rapidly for decision-makers (Comfort et al, 2001).

One of the major aspects of leadership decision-making that is frequently overlooked is the ability to deal with the paradoxes that are present in many non-routine situations (Batorski, 2011). Such paradoxes create tensions for the decision-making and create potential conflicts with other decision-makers and constituents. Effective 'paradoxical leadership' is rarely present in routine management, and is therefore usually insufficiently practised³⁷ when required for the non-routine. This in turn can generate another paradox, the perception of insufficient management of risk before an incident then influences decisions that generate conditions that will lead to a different incident in the future (Burby, 2006). One of the common paradoxes encountered in a rapidly changing situation is the need to establish central control to provide overarching sensemaking, direction and a coordinated approach, versus the need to allow a more distributed leadership and decision-making closer to the front line. Paradoxes will also create tension within the decision-making processes itself, for example a leader's prior decisions (during BAU) can often contribute to the vulnerabilities that have given rise to the current disruption. That same leader is then faced with making decisions that are counter to those earlier decisions (Turoff, 2015), creating cognitive and emotional conflict.

Perhaps one of the overall key determinants of leadership-driven resilience is the ability to handle the paradox that an organisation under stress is a very different context compared to a routine state. Hence an organisation faced with disruptive conditions requires very different thinking and management to ensure strategic success, whilst at the same time requiring some routine management thinking and capability to meet ongoing operational objectives³⁸. The other major aspect of leadership and paradoxes is that the combination of effective leadership and a highly unstable state provides the opportunity for the emergence of even higher levels of resilience.

A key role of the leader is that of assessing the capabilities for, indicators of, and other evidence for resilience within the organisation (Adler and Saboe, 2017). This will usually require a determined effort to readdress the common demands for short term performance results and pursuit of immediate

³⁵ Where 'tone' encompasses cultural concepts such as work ethic, leadership styles, relationship styles, expression of positivity (or negativity), integrity, energy levels, expression of encouragement and recognition.

³⁶ A key aspect of leadership is in the setting of 'emotional tone', which will influence how individuals and teams perceive and make sense of situations, make decisions in those situations, the behaviours they will exhibit, and the actions they will ultimately take (Pelser et al, 2013).

³⁷ Again, dealing with paradoxes is not a common explicit objective for emergency/crisis exercises, although these can provide an excellent opportunity to develop these skills, and can be easily included in desktop as well as field exercises.

³⁸ During a critical incident there is still the need to achieve a balance between 'non-routine' and 'routine' activities.

personal recognition, which too often discourages a longer-term outlook and concentrated thinking about planning, preparedness and resilience (Ghosal, 2005; Kennedy, 2000; Albert, 1993).

Higher levels of resilience are often associated with more devolved or local leadership (Shaw, 2012; Avery and Bergsteiner, 2011; Stewart and O'Donnell, 2007), and decision-making that is distributed³⁹ (Braithwaite, 2017; Gustavsson, 2011; Seijts et al, 2010; Greenfield et al, 2009; Marion and Uhl-Bien, 2007; Bennet et al, 2003). Distributed leadership and decision-making is associated with greater group cognitive complexity and capabilities, a requirement for dealing with the sort of complex and wicked problems found in non-routine situations, and as a consequence provides the sort of openness and concerted effort from a team that is required under conditions of duress.

Transformational leadership (Witmer and Mellinger, 2016), has been associated with improving resilience. Breaking down hierarchies, encouraging collaborative problem solving and decision making, and creating alignment to a common purpose (Waugh and Streib, 2006). All of which help positive internal emergent change to occur (Dickens, 2015), contributing to improved resilience. During a crisis, transformational leaders enhance the personal resilience of the individuals and team members that follow them (Sommers et al, 2016), whilst more passive leadership degrades resilience.

It is not uncommon for an organisation to rely on all of their senior managers to continue to provide leadership during periods of crisis and disruption, despite the likelihood of some being ill-suited for such situations. In fact performance in routine environments may preferentially select for individuals less able to cope under stressful conditions. Early research (Goodwin and Ziegler, 1998) suggests that in low complexity simple work environments those individuals with higher cognitive complexity are disadvantaged, favouring the promotion of less able individuals. Progressively, over time, this results in senior management levels having a disproportionately higher number of lower cognitively complex individuals within their ranks (Pim, 2019; Templer, 2018; Conerly, 2018; Crowley, 2015). Thus such leadership becomes less likely to be able to deal with complex non-routine environments. In such situations where senior management is less cognitively able to operate in complex environments, the presence of distributed leadership (which allows required expertise to be accessed at all levels) becomes a key enabler of resilience.

Anticipation, vigilance and awareness

Anticipation helps to provide an answer to one of our model criteria questions: “resilient to what ?” Anticipation allows sense to be made about the present and provides insight into what could happen in the future (Zsidisin and Wagner, 2010; Boyd et al, 2015).

Improved anticipation drives preparedness, whilst improved visibility and vigilance drives agility (Weiland and Wallenburg, 2012). Anticipation contributes to resilience by providing insight into the multiple possibilities that could happen (Bresch et al, 2014), through thinking about:

- What could happen in the future.
- How this could interact with the organisation to cause harm, disruption, or opportunity for benefit.
- What the organisation could do about this future potential harm, disruption or opportunity.

³⁹ Distributed leadership ‘emerges’ as a result of interaction between individuals and groups of individuals, and is closely associated with ‘deference to expertise’ seen in high reliability organisations (Enya et al, 2018, Wheeler, 2015; Christianson, 2011; Liddy 2005).

Anticipation requires gaining insight and understanding into what is happening through vigilance, visibility, and situational awareness (Burnard and Bhamra, 2011), and how the current situation could evolve (Endsley et al, 1994). By their very nature, anticipation and vigilance are integral parts of organisational learning, providing the means of learning about the future. If there is inadequate understanding of *'what'*, then there can be little informed preparedness for *'when'*. A dynamic and continuous process of anticipation and vigilance are essential for the resilience of individuals and teams (Lengnick-Hall et al, 2011), as well as for the organisation as a whole. As part of this consideration, it is also important to understand how the immediate and impending disruptive conditions are imposing barriers and constraints on current effective operations (Burnard, 2016). This encompasses both exploring early warning indicators of plausible future external threats to an organisation, and considering the prospect for future internal vulnerability to those threats (Fiksel et al, 2015; Proag 2014b).

Anticipation is not about *prediction*, the tools that assist in anticipation are more explorative and speculative than those used in traditional forecasting. There are a range of tools and techniques to help develop better anticipation, including applying intuitive thinking (also incorporates 'gut feel'), foresighting, horizon scanning, simulations and modelling (GCPSE, 2014: Rerup, 2001; Wollenberg et al, 2001) and a range of contemporary risk analysis methodologies to help explore and create an understanding of potential future contexts. These analytical tools can be supported by other techniques such as scanning and monitoring, emerging issues identification, challenging assumptions⁴⁰, issues and vulnerability audits, etc. (Ashely and Morrison, 1996).

Sensemaking

In complex systems the *'when'*, *'how'* and *'where'* of the vast range of potential interactions become even more uncertain as volatility, turbulence, and the potential for disruption increases (Pich et al, 2002). Sensemaking provides a common understanding of what is important for the organisation (in order to achieve its purpose), what is happening within and outside of its environment, and how to address the complexity and change that it is faced with (Ruiz-Martin et al, 2017).

Sensemaking involves enhanced capabilities for anticipation, situational awareness (Craighead, 2007), and monitoring and surveillance for the detection of future change that will have both near and longer term effects. (Tadic et al, 2014; Oh and Teo, 2006). This may include detecting and exploring *'near misses'* (Sheffi, 2007) arising from changing conditions, and developing an understanding of organisational vulnerabilities to such conditions (Sanchis and Polar, 2013; Burnard and Bhamra, 2011).

Other aspects of sensemaking are often forgotten about, but are as important, including how individuals undertake cognitive and emotional thinking and decision-making, and how their interaction with other individuals and teams affects their own and shared sensemaking.

The contribution of effective sensemaking to resilience, is perhaps best illustrated by considering the increased risk of disruption and failure in its absence. The Royal Bristol Infirmary experienced unusually high levels of paediatric deaths during heart surgery, which continued without serious intervention, for a period of fourteen years. A subsequent Government Inquiry (Kennedy, 2001) revealed that a serious collapse in sensemaking over this time was a major contributing factor in the deaths (Kewell, 2007). The Inquiry also found that a *'culture of entrapment'* had developed at multiple levels of the organisation, which allowed continuing poor surgical outcomes to be rationalised and legitimised. This in turn created a continuing optimism that future performance would improve,

⁴⁰ For example by using red teaming techniques (Tang et al 2020; Zhang and Gronvall, 2018; Mansfield-Devine, 2018; Hoffman 2017; Kardos and Dexter, 2017)

despite these continuing disastrous outcomes (Weick and Sutcliffe, 2003). A number of other contributing factors were identified by the Inquiry including poor teamwork, “too much power in too few hands”, combined with a punitive management style that made speaking out unsafe. The problems were not limited to surgical arrangements alone, with multiple failures from NHS processes before children reached the hospital, through to post-surgical intensive care (Dyer, 2001). These are issues that were not isolated to the Royal Bristol Infirmary, but were issues that appear to have been prevalent more broadly across the National Health Service (Pope, 2017; Pope and Burns, 2013).

An often overlooked aspect of sensemaking (as it is closely connected to leadership) is the ability to understand and make decisions (at all levels of an organisation) about the inherent paradoxes and tensions that, whilst often present in business-as-usual (Sparr, 2018; Bason, 2018; Hood and Peters, 2004), take on special significance in non-routine situations (Schad et al, 2017; Lewis et al 2014). Typical paradoxes that create competing demands include:

- The need to achieve stability, whilst retaining adaptability.
- Maintaining control and governance whilst allowing flexibility, independence and autonomy.
- Providing rapid tactical responses whilst establishing long term strategic solutions.
- Attaining full situational awareness whilst avoiding paralysis by analysis.
- The financial resilience provided by insurance versus its influence on increasing ‘risky behaviours’ (O’Hare et al, 2016).
- The need for comprehensive planning for future eventualities versus the inherent entrenchment and inertia that such planning can generate (Lewis et al, 2014)
- Diversity which provides multiple different experiences and expertise versus diversity which requires attention to be divided across multiple constituencies (Duchek et al, 2019)

Teamwork

Organisational resilience is highly dependent upon the contribution of organisational, team and individual performance (Wang et al, 2011), with team capability being a major driver of resilience in most organisations. Without an effective team, many individuals would struggle to make a meaningful contribution to organisational resilience.

Team composition, including diversity (of experience, personality and capability) has a direct effect on the team’s cohesion, viability and performance (Bell, 2007), whilst a diversity of perspective can improve problem solving and performance. Conversely, group-think can substantially degrade resilience (Smith et al, 2009; Hong and Page, 2004). The existing relationships and interactions within the team, under routine conditions, will largely determine how the capabilities required for resilience will still be available and accessible under non-routine conditions (Carmeli et al, 2013).

Research indicates that the resilience of teams is underpinned by a number of psychosocial processes (Morgan et al, 2015), including social identify, trust, transformational and shared team leadership, team learning, and positive emotions.

Learning to be different

Routine operations are often characterised by a ‘performance orientation’, where management has a focus on goals and rational decision-making (Kayes and Yoon, 2016), which in many organisations becomes an overriding focus on short-term goals (Bircham and Connolly, 2013). There are indications that such performance orientation reduces organisational resilience in the face of emerging novel non-routine conditions. Those organisations that demonstrate a shift to a more learning orientation generally demonstrate higher resilience.

Four stages of learning have been described following a disruption (Kayes and Yoon, 2016):

- Individual learning.
- Group learning.
- Organisational learning.
- Sector/industry-wide learning. Industry-wide learning in particular is often ignored, but can provide the opportunities for others to learn without the costly experience of a disruption.

Learning from experience is vital to establishing resilience, and needs to occur at an individual, team, and organisational level. It is not sufficient for some form of non-specific and *ad hoc* experiential learning to occur. Learning needs to capture and exploit tacit⁴¹ knowledge (Chand and Loosemore, 2012; Nonanka and Nishiguchi, 2001).

Both direct experiential learning, and the capturing and sharing of lessons learned are vitally important in improving organisational resilience (Nilakant et al, 2014; Jaarin and Backhouse, 2014; Kendra and Wachtendorf, 2003; Carley and Harrald, 1997). It also important to remember that experiential learning is not just gained from actual events, since learning gained from well-constructed simulations can be as powerful and enduring (Bergström et al, 2011). Indeed, learning from simulations can sometimes be more effective, when lessons are specifically targeted to address capability and knowledge gaps and needs. In such simulations memory development will be less adversely affected by strong emotional stimuli (compared with real incidents), provide more opportunity for reflection, and will allow learning to be more effectively encoded in long term memory.

To be effective, 'learning' has to be established as a cultural norm, which assists in the recognition and open discussion of error and potential disruption. This can allow assumptions and problems to be surfaced and dealt with in the early stages of 'precursor events'. It may not be sufficient just to have 'learning' established as part of the 'routine culture'. The very nature of disruption may disable learning capability, requiring the resilient organisation to be able to rebuild that learning capability (Kayes and Yoon, 2016). Where organisational learning breaks down, it is often accompanied by overall organisational failure, for example as experienced in the collapse of Lehman Brothers during the Global Financial Crisis (Kayes and Yoon, 2016).

It is also important to realise that for learning to contribute to enhanced resilience it is not sufficient to merely learn from the past. Understanding and learning about contemporary and future contexts can be equally important (Figure 19).

⁴¹ Tacit knowledge is highly personal and is held by an individual that they may not consciously recognise.

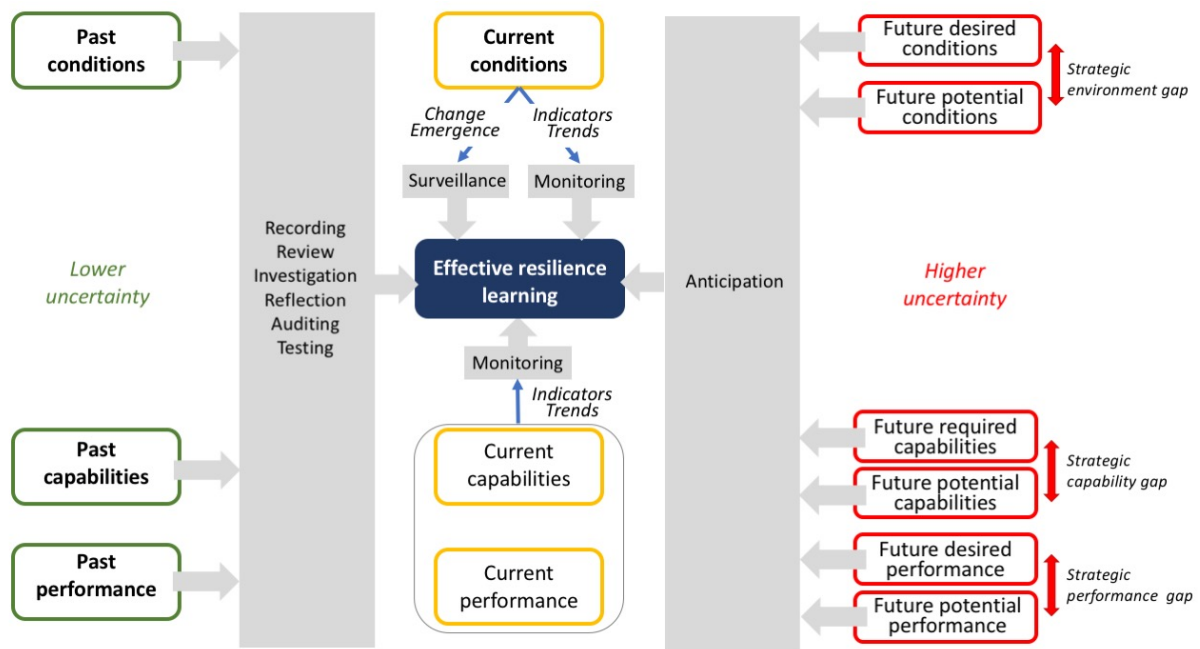


Figure 19: Looking backwards and forwards for effective resilience learning

Enabling capabilities

Organisational culture

The importance of culture⁴² in influencing key strategic and operational decisions and their implementation has been recognised for some time (Schein, 1985). Organisational culture also has a profound influence on how an organisation approaches unplanned change (both before and after it occurs), and is a key determiner of resilience (Branicki et al, 2019; Nachbagauer, 2019; Pradhan and Bhattacharyya, 2018; Vos, 2017), influencing how an organisation collectively and people individually prepare for, become aware of, make decisions about, respond to, and recover from disruptive events. Any response to disruptive change that ignores an organisation's culture is unlikely to be fully successful in achieving its aims. Particular aspects of organisational culture have been shown to have a direct positive effect on resilience, including the level of people's commitment to the organisation's mission (Witmer and Mellinger, 2016, Coutu, 2011), combined with an optimistic outlook and hope for the future. Optimism can be especially important, where it demonstrates an attitude that views the problems of disruption as only temporary setbacks. Such a positive outlook is in turn an outcome of high personal resilience provided by access to a range of cognitive and emotional resources (Jackson et al, 2007).

Certainly, where organisational culture is not dominated by authority and power structures, but instead promotes independence and the contribution of teams and individuals, improved resilience can be demonstrated (Crichton et al, 2009). Whilst this in turn is dependent upon the establishment of trust, openness and transparency (Jones et al, 2017; NATO, 2017; Akgün and Keskin, 2013).

⁴² Organisational culture is the collective manifestation of underlying assumptions, beliefs, values and behaviours from across the organisation. In reality an organisation may comprise a range of different subcultures in different areas of the organisation and at different levels of the hierarchy. These subcultures will not exert an equal influence and at certain times and in certain contexts some subcultures will predominate.

People aspects of organisational resilience

A lot of the thinking and published literature about organisational resilience has focussed on planning for the protection and availability of tangible 'stuff' (infrastructure, processes and other physical resources). This attitude has been driven, in part, both by the propensity of emergency management for traditional 'preparedness' and by some of the business continuity profession's unfortunate obsession with rigid planning and linear thinking. Such thinking ignores the core features of complex sociotechnical systems, particularly that such systems' future reaction and behaviour cannot be accurately predicted, and that the exact nature of organisational response cannot be fully pre-specified (Havinga et al, 2015).

When faced with potentially disruptive conditions, an organisation will invariably have capability gaps, hence the need for 'agility', 'flexibility' and 'adaptability'. However, it seems to be frequently ignored that it is the people within (and sometimes externally to) the organisation that will need to fill these gaps. It is these people that create resilience, often by stepping outside of well-established routines of work, and being innovative and opportunistic to evolve, even temporarily, their approach to their work (Havinga et al, 2015), both individually and as a team.

It has been suggested that the development of resilience involves people undergoing a change of mindset on how they view their environment and their own place within it (Böggemann and Both, 2014). Such mental reframing requires the creation of a deep shared insight into interdependencies and how these contribute to success. Such focussed sensemaking is built upon a dialogue across stakeholders. With the creation of a different sense of what is happening and what is required, it becomes easier to free up resources at the interface of silos and other boundaries, to focus on further building capability.

A range of employee attributes have been linked to improving organisational resilience, including: competencies and skills, cognitive and emotional capability (and flexibility), resourcefulness, and the level of social support available (Lengnick-Hall et al, 2011; Luthans et al, 2007). Of particular importance are psychosocial factors such as: cognitive and sensemaking capabilities, analytical and emotional thinking and decision-making skills, cognitive biases, and the mechanisms by which risk is socially amplified. This also includes consideration of the individual and collective attitude held by people within the organisation, including a willingness to step up and act when changing conditions require key individuals to reach outside of their day-to-day roles. In such situations the existing level of trust then acts either as a predominant enabler, or a deterministic barrier to resilience.

Personal resilience

The capability of an organisation to respond to and to take action to prevent or manage disruption, entirely rests on the continued availability of those people to undertake their expected roles and their ability and willingness to step beyond those roles when required. Their availability and willingness are entirely dependent upon their personal resilience to the conditions and impacts facing the organisation. This personal resilience provides the means to cope with unwanted effects of stress, facilitates ongoing cognitive and emotional capabilities (including the ability to make sense of a developing situation), the ability to improvise, and the ability to keep decisions and behaviours aligned with organisational goals and objectives (Sommers, 2009; Heese et al, 2013). There is a wide range of psychology literature devoted to individual or personal resilience, much of it associated with recovery from trauma or mental health issues (McLarnon and Rothstein, 2013; Shin et al., 2012; Pipe et al, 2012; Bonanno, 2004).

Personal resilience is commonly regarded as a capacity to bounce back to a normal functioning pre-trauma state. Personal resilience may be an innate trait of an individual, although resilience can also

be built upon and enhanced by individual learning of certain cognitive, emotional and behavioural attributes and skills (Salisu and Hashim, 2017; Baker, 2016; Britt et al, 2016; Windle et al 2011; Sarkar and Fletcher, 2014; Dane, 2011; Reich et al, 2010; McAlister and McKinnon, 2009; Ong et al, 2009; Firtko et al, 2007; Agaibe and Wilson, 2005; Tugade and Fredrickson, 2004; Richardson, 2002; Masten, 2001; Simonton, 2000). This includes attributes and skills associated with a person’s attitude, temperament, behavior and the nature of their connections with others (summarised in Figure: 20).

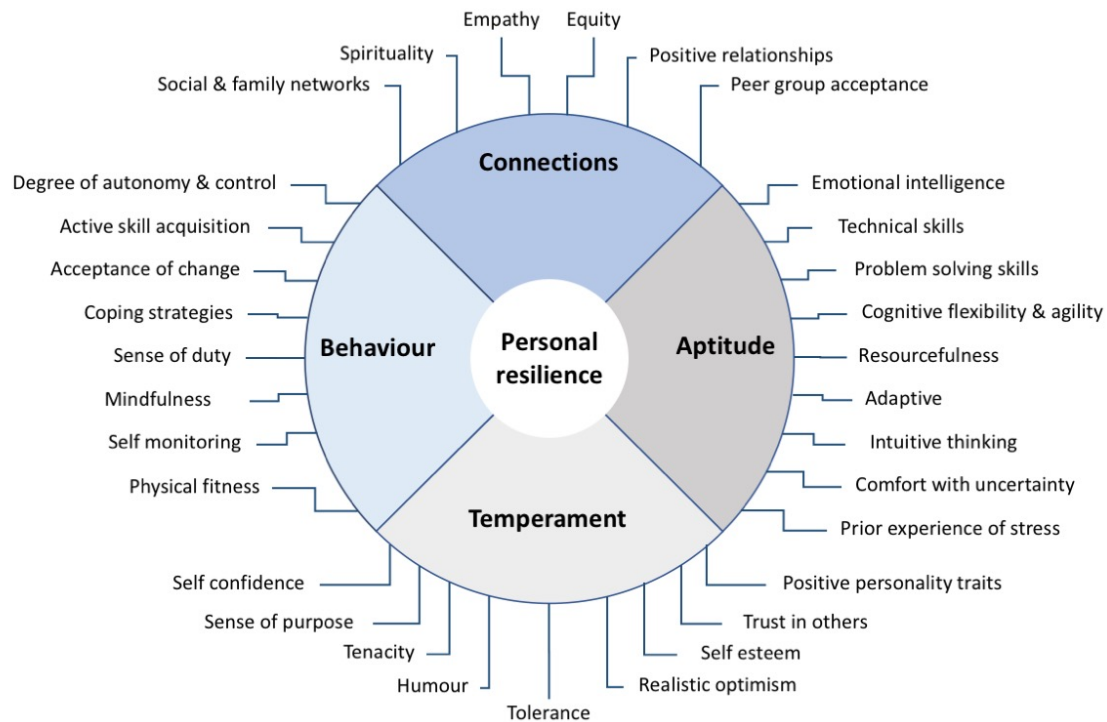


Figure 20: attributes and skills associated with personal resilience

Conversely, low personal resilience in the face of excessive stress is often associated with a reduced ability to deal with emotions, loss of attention, reduced cognitive abilities and impaired decision-making (Spangler et al, 2012).

Broad organisational programmes aimed at building workforce resilience have had questionable success (Vanhove et al, 2015; Robertson et al, 2015), although activities targeted to address specific weaknesses in individuals have been more productive (so called primary prevention programmes). However, some organisations, such as the US military, invest significantly in programmes to build personal and psychological resilience, and have great belief in their benefits (Yeung and Martin, 2013; Meredith et al, 2011). Such programmes which are aimed at introducing a range of improvements (Meadows et al, 2015; Shih et al, 2015; Robson and Salcedo, 2014) are based upon preventive measures that can address ‘environmental stress’ before individuals are exposed to it, whilst protective measures are established to deal with the effects of exposure to such ‘environmental stress’. Mindfulness training has been shown to be particularly useful in strengthening personal resilience, particularly for individuals and team facing extremely unpredictable high stress environments. For example, the use of mindfulness training in US military units pre-deployment has shown increased attentional performance and reduced post-deployment psychological problems (Jha et al, 2020; Jha et al, 2015; Brewer, 2014) .

A number of other supporting factors have been associated with improving personal resilience more broadly within society, including socio-economic status and financial stability, access to suitable housing, education level, access to support services, availability of transport, meaningful employment, etc. (Windle, 2011).

Diversity

Diversity has long been associated with enhancing resilience, the “Law of Requisite Variety” positing that increasing diversity directly contributes to that network’s or system’s ability to respond to unforeseen change (Anklam, 2007; Folke et al, 2002). Diversity has been shown to increase the range of perspectives and capabilities that can be applied to different changing conditions and effects, and enhances creativity and innovation (Reinmoeller and van Baardwijk, 2005). Whilst diversity in resourcing, processes, etc. can be important (Goumagias et al, 2016; Clarke et al, 2015), the key to organisational resilience lies in the diversity of its people. However, this diversity is not the restricted view of just gender and racial diversity usually espoused by the typical HR Department. What is really important is that embracing diversity brings together people with widely different expertise, skills, knowledge, life experiences, attitudes, etc. (Nwachukwu and Robinson, 2011), providing a significantly expanded referential and analytical frame.

Employee engagement

Employee engagement and wellbeing have been strongly linked with improving both personal and organisational resilience (Kuntz et al, 2014; Näswall et al, 2013). Engagement is highly dependent upon the ongoing maintenance of trust between management and employees (Macey and Schneider 2008). This trust is manifested in the so called ‘psychological contract’ which expresses how management and employees should behave towards one another (Makin et al, 1996; McDonald, 2000). Psychological contracts can be placed under significant adverse pressure during organisational change and disruption (Freese et al, 2011), and as these psychological contracts are breached, employee trust and engagement is lost, individuals are less willing to ‘step up’ and go beyond their substantive duties (McCoy and Elwood, 2009), and accordingly resilience is degraded.

Collaboration

Collaboration, between different areas of an organisation, or between different organisations, provides a range of benefits that contribute to resilience, that occur at strategic, operational and tactical levels (Andrés and Poler, 2013) through a variety of different mechanisms. This can include mutual support through providing access to a wider pool of resources and expertise (increases capacity, diversity, and redundancy) to deal with a disruption, particularly where the incident or effects span organisational, geographic or jurisdictional boundaries (Albani and Henderson, 2014). Such mutual support may provide improved communication and sharing information about changing conditions, thereby enhancing sensemaking. It may also involve working together directly to avoid or minimise exposure to stressors such as social and environmental impacts (Smith, 2014).

Collaboration is driven and facilitated by trust and transparency, which together help those with the appropriate expertise to more clearly identify the problems and fix them (Cascio, 2009). Creating new, or building upon existing networks greatly strengthens both intra- and inter-organisational collaborative relationships and networks (Boin and t’Hart, 2010). However, caution does need to be exercised as in some cases the complexity and opacity of many network relationships can ‘hide’ hierarchical and power relationships that adversely affect connectivity in collaborative relationships (Kerr, 2014). Such degraded relationships can decrease the ability to anticipate adverse change, and

increase the potential for 'contagion' from disruptive conditions, further reducing resilience (Fridgen et al, 2015).

Flexibility and adaptability

There is a philosophy that failure is not only possible, but that it is eventually inevitable (Dekker, 2015, 2006; Downer, 2011; Croskerry, 2009). Accordingly, the ability to 'fail gracefully', in a controlled and manageable manner and recover rapidly (minimising further harm and limiting costs) become key resilience attributes (Cascio, 2009). This obviously requires adaptive capacity and the ability to reduce vulnerability (Gallopín 2006; Erol et al, 2010; Dalziell and McManus, 2004), along with the ability to reinvent the organisation around core values (Alpaslan and Mitroff, 2004; Hamel and Valikangas, 2003). A particularly important (but often ignored) aspect of adaptation is the willingness to question the changing relevance of current objectives and the decisions being made in their pursuit, which may require prior decisions and actions to be modified or abandoned when these are no longer appropriate to the current environment.

Innovation and creativity make important contributions towards flexibility and adaptability, and it has been suggested that greater resilience can be achieved through a dynamic balance of four innovation strategies (Bristow and Healy, 2018; Ferreira et al, 2016; Mafabi et al, 2015; Folke et al, 2010; Reinmoeller and van Baardwijk, 2005):

- Knowledge management: exploiting existing repositories of organisational knowledge.
- Exploration: where there is an active search for new ideas and new knowledge.
- Cooperation: sharing resources and ideas with other organisations to create further innovation.
- Entrepreneurship: where new resources and applications for ideas are sought, often outside of existing organisational boundaries.

System Modularity

Organisations with strong functional and structural modularity are better able to contain the contagion of disruption as it starts to spread, compared to those organisations with high levels of interlinkage and interdependency (Bresch et al, 2014). Whilst such decentralised capabilities may be less efficient under BAU, they are less likely to fail catastrophically compared with more centralised systems. Should organisational components become impaired, modularity allows for:

- A simpler and more rapid replacement of failed components.
- Increased flexibility for reorganisation or rescaling.
- Decentralised essential capability, placing this capability closer to the operation where it is required.
- A reduced chance of single points of failure.
- Decreasing an organisation's overall exposure to localised conditions that would otherwise be highly disruptive to that entire capability (Cascio, 2009).

Access to capability and resources

Access to a range of physical resources and capabilities can play an important role in enabling resilience. These resources may be available from business-as-usual operations, or may be provided through a range of contingent arrangements (Cascio, 2009). In both cases organisational cohesion, the manner in which key organisational aspects such as processes, knowledge, expertise, culture etc. are joined together becomes a major predetermining factor (Fiksel, 2003), along with the ability to improvise within existing and available resources (Witmer and Mellinger, 2016).

Physical resources may not be limited to budgets, facilities, plant, assets and inventory, but should also include ‘human resources’ and services delivered by other parties. The majority of these resources are embedded within relationships, constituting ‘social capital’ (Bauweraerts, 2016; SMR, 2016; McGuinness and Johnson, 2014; Ollerenshaw et al, 2014; Nicholls, 2012; Johnson, 2010), and are most easily accessed through exploiting this social capital.

Social capital has been described in terms of three highly interrelated ‘clusters’ (Nahapiet and Ghosal, 1998):

- A structural dimension: the properties and the network of relationships as a whole – i.e. how resource flows occur and are managed.
- A relational dimension: the manner in which resources are established and managed through personal relationships that have been developed.
- A cognitive dimension: “shared representations, interpretations, and meaning” that are applied to these resources.

Whilst having sufficient and available funding contributes to organisational resilience, ensuring that there is sufficient transparency and accountability with regards to fiscal arrangements is also of importance (Witmer and Mellinger, 2016).

The nature of the dependencies and interdependencies, particularly the effect that disruptive conditions will have on their availability and access, can have a significant influence on resilience. However, an organisation that is truly agile, flexible and adaptive may have a lower critical dependency on physical resources and capabilities as their loss can be more readily accommodated or compensated.

The effective management of risk

Arguments have been put forward that risk and resilience are distinctly different (Fiksel et al, 2015), but operate in tandem: risk management focusing on foreseeable scenarios, whilst resilience provides for both foreseeable and unanticipated events (Van der Vegt, 2015; Linkov et al, 2014). However, there are other perspectives that consider risk and its management as providing the basis for building resilience (Davidson et al, 2016; Burnard, 2016; Pantelli and Mancarella, 2016; Scholten et al, 2014; Lei et al, 2013), with critical success factors identified as:

- ‘Containment,’
- ‘Leadership’,
- ‘Communication’,
- ‘Speed of response’,
- ‘Access to resources and expertise’.

Despite the value of reducing the potential for future disruption by modifying risk, traditional risk management approaches can have substantial limitations in their contribution to organisational resilience. Most contemporary risk management practices (including applications of ISO31000 and COSO) are based on linear thinking and linear processes⁴³ which struggle with high complexity and uncertainty (Linkov et al, 2014). Such linear thinking, usually assumes that risk occurs over a normal distribution. However, where disruption-related risk and complex systems are concerned, this assumption is often invalid. It is more likely, than imagined, that risk will be characterised by ‘fat tails’. In these situations there is an increased likelihood of high consequence values (with assumed very low probabilities) being encountered (Albani and Kupers, 2014), and with the so called ‘black swan’ events occurring far more commonly than expected.

⁴³ Just redrawing a step by process into a circle doesn’t change it from a linear progression.

Commonly encountered practices of risk management also often examine system components individually and in isolation of their interdependencies on other components, rather than encompassing a more whole of system perspective. This will often produce misleading results since the examination of components taken in isolation rarely reflect how they behave when part of a larger system.

Resilience is an outcome of the *effective* and *ongoing* management of risk. As measures are put in place to modify risk, it is expected that resilience will increase for the *context within which risk management is occurring*. However, resilience may be unaffected or even deteriorate for other contexts for which the risk is not directly addressed. For example, an organisation may invest significantly in treatments to address the risk of critical infrastructure failure and would therefore be expected to demonstrate high resilience in the face of any future prolonged power outages. However, this would not necessarily translate to high resilience for other organisational activities or for other scenarios, such as a reputational crisis.

Fragility and antifragility

Vulnerability

There are many definitions of vulnerability (Waters, 20011; Miller et al, 2010; Seery et al, 2010; Briguglio et al, 2009; Buckle et al, 2000), although in some disciplines such as ecology and disaster management there are more generally accepted (Lindoso, 2017). Vulnerability is often expressed in terms of control imperfections in day-to-day operation of a system, and occasionally in terms of a system under stress. In terms of resilience, the vulnerability of an organisation and its interactions with its environment are of primary importance. The common practice of considering vulnerability if individual components (in isolation) is likely to be a poor reflection of overall vulnerability.

Less commonly, the term 'brittleness' has also been applied to the potential for system failure under non-routine conditions, whilst the term 'vulnerability' has been used to refer to this potential under routine conditions. Additionally the term fragility has been introduced to describe the potential for failure under both routine and non-routine conditions:

$$\text{Fragility} = \text{vulnerability} + \text{brittleness}$$

However, these differences are semantic, and in common practice the term 'vulnerability' is often used synonymously with how 'fragility' is being used as an overall term.

There is a close relationship between resilience and vulnerability (Dalziell and McManus, 2004), and a direct inverse relationship has often been applied, i.e. opposites to each other (Folke et al, 2002; Kaly et al, 2002). This may seem intuitively right, however, in reality the two concepts are not direct opposites, and the relationship is often non-linear and asymmetric (Weichselgartner and Kelman, 2015). For example, it is possible for an organisation with significant vulnerabilities to still demonstrate high resilience, and for an organisation with a low apparent level of vulnerability to also have poor resilience. Other authors have taken a different view on the relationship, such as vulnerability representing the degree to which a system is affected by a shock, and resilience reflecting the degree to which the system can recover from that shock (Gitz and Maybeck, 2012)

Conceptually, vulnerability conveys an idea of 'weakness', within a system, but can be more specifically thought of as the potential for a system (or part of a system) to adversely react to changing conditions (Proag, 2014b). Vulnerability is directly related to the context, since a system may exhibit vulnerability to certain stressors but not to other stressors. This is also intimately associated with risk

and uncertainty since the expression of a vulnerability is not certain, and is dependent upon a coincidence of other factors (often unknown) also occurring.

Different types of vulnerability may be present within a system, including:

- Political vulnerability, relating governmental and jurisdictional aspects of systems.
- Physical vulnerability, relating to built assets.
- Ecological vulnerability, relating to living systems.
- Economic and financial vulnerability.
- Workforce vulnerability, relating to the availability and performance of the workforce.
- Social vulnerability, relating to the broad interaction of people.
- Network vulnerability, relating to the interactions across different systems (such as inter-organisational relationships), as well as physical and logical networks.
- Psychological vulnerability, relating to cognitive and emotional capabilities.
- Knowledge and information vulnerabilities, relating to access, completeness, accessibility integrity etc..
- Communication vulnerabilities, relating to both the messages being relayed, and the channels by which the communication occurs.
- Resource vulnerabilities, relating to resource integrity, access, availability etc.
- Process vulnerabilities, relating to fitness for purpose, stability, error and deviance.

These vulnerabilities may be present in any combination, and be independent, or interact further amplifying the overall level of vulnerability.

Antifragility

The term antifragility has been used to describe an ability to learn, innovate and continue to grow in turbulent conditions (Taleb, 2012), with the contention that antifragility is different to resilience. The implication has been that antifragility is focused on knowledge and learning derived from interactions with disruption, promoting evolution and growth (Verhulsta, 2014; Jones 2014, De Florio, 2014). This of course has assumed a very limited definition of resilience solely as a survival response to disruption. Conversely, many others believe that resilience encompasses learning, innovation, evolution and growth (Bruegger et al, 2019; Evans et al, 2019; Geha, 2019; Lucy and Shepherd, 2018, Cooke, 2017; de Kraker, 2017; Raman and French, 2017; Alberti, 2015; Kayes, 2015; Parast et al, 2015). Antifragility can therefore be seen as a special case of resilience, one where the system gains (rather than suffers) from disruption, and where, under high uncertainty, the system is able to function without the need to resolve that uncertainty. It is probable that there are many systems that require disruption in order to be sustainable in the long term (for example to drive innovation), and that in the absence of disruptive conditions they will not thrive.

Community resilience

A detailed discussion about community resilience is beyond the scope of this paper. However, some aspects are considered to provide a border context and relational frame for organisational resilience.

Community resilience is most often referred to in the context of major disasters, but without a consensus on what community resilience actually is (Patel et al, 2017; Haase et al, 2017; White et al, 2015; Yellman and Murray, 2013; Uscher-Pines et al, 2013). Collectively much of the published work associates community resilience with activities such as: anticipating problems and opportunities, managing vulnerabilities, responding to disruption, and recovering rapidly (NIST 2016; Plough et al, 2013; RAND, 2015; Wilbanks, 2009).

Models of community resilience

Multiple models of community resilience have been proposed, most involving the effect of multiple interrelated factors or 'levers' of resilience (Wulff et al, 2015; Pfefferbaum et al, 2015; Cox and Hamlen, 2015; Houston et al, 2015; IFRC 2014; Chandra et al, 2014, 2011, 2010; Plodinec et al, 2014, 2013; Chen et al 2013; Cutter et al, 2008b). This includes factors such as:

- Community leadership, including:
 - Governance and leadership.
 - Preparedness.
- Sustainability
 - Level of economic development.
 - Environmental sustainability.
 - Access to essential resources.
 - Levels of social support and social connections
 - Integration of governmental and non-governmental institutions.
- Awareness and understanding:
 - Access to information and communications.
 - Local knowledge.
 - An ability to learn from prior events and actions, including learning from success as well as learning from failure, and the ability to make sense of and learn from adverse conditions as they develop. This learning drives community adaptation.
- Individual and population attributes:
 - Physical and psychological health of the population.
 - Wellness.
 - Education levels.
 - Self-sufficiency and self-reliance.
 - Quality of life.

As with other types of resilience, it is the interrelationships and interaction amongst the components that establishes community resilience as a sum that is greater than its parts (Eachus, 2014). Additionally, community resilience may increase following a major disaster where increased social and psychological strength, along with an expanded sense of belonging (Norris et al, 2010; 2008) contributes to so called 'community post traumatic growth' (Bonnano, et al, 2010). This has also been expressed as the strength of a range of 'community capitals' (Flint, 2010; Flora and Flora, 2008), summarised in Figure 21.

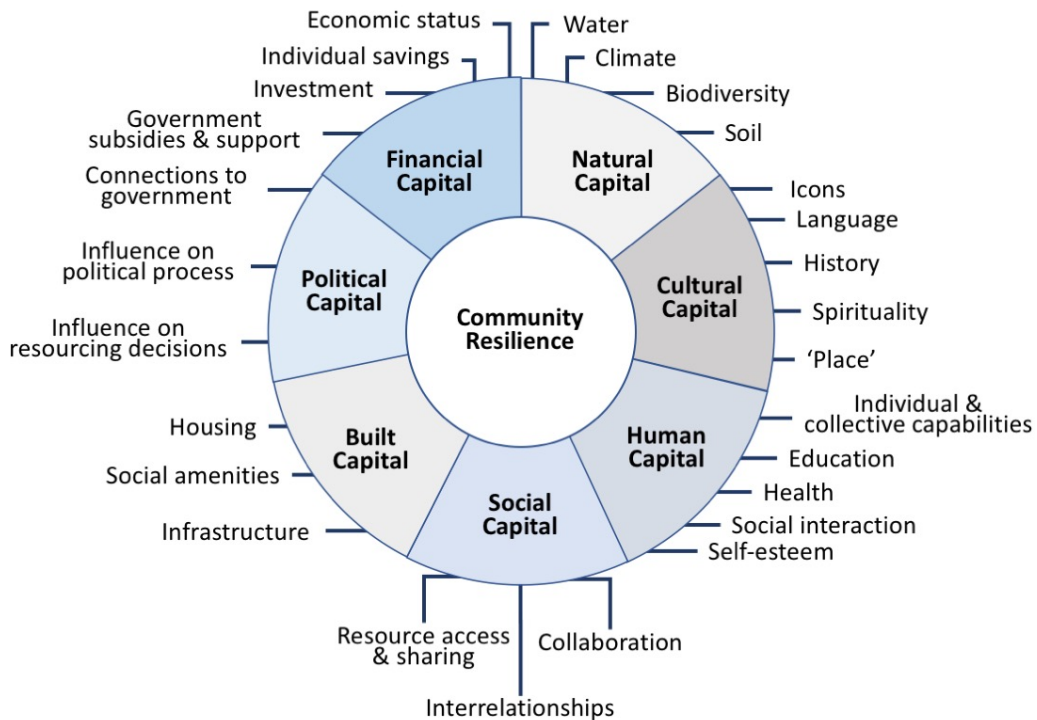


Figure 21: The capital model of community resilience

Building community resilience

Several toolkits have been developed to help build community resilience (Keating et al, 2017; Chandra et al, 2014; Eisenman et al, 2014; FSIN, 2014). These recommend a range of activities to be undertaken (also see Figure 22) including:

- Improving sensemaking of, and about the community:
 - developing an understanding of the community’s context (key features of the community, available resources, community strengths and weaknesses, key interdependencies, etc.);
 - understanding and prioritising hazards and threats to the community;
 - understanding and prioritising other community challenges;
 - exploring areas of vulnerability, including ‘at risk’ or otherwise vulnerable populations within the community.
- Establishing and developing collaborations:
 - identifying important community and external stakeholders and their needs and contributions;
 - building on relationships and developing partnerships and other collaborations.
- Planning for improved resilience:
 - identifying priorities for taking action;
 - gaining access to, and sharing required resources.

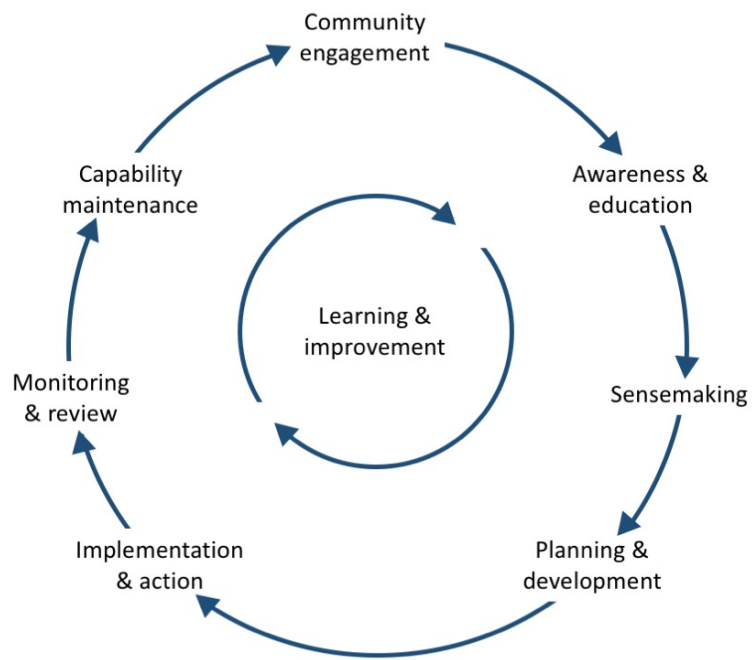


Figure 22: generic process for building community resilience⁴⁴

⁴⁴ Although the diagram illustrates the building of community resilience as a progressive step by step process. Ideally the process should be iterative, recursive, and reflective.

The absence of resilience: organisational failure

The study of organisational resilience has focused almost exclusively on the means by which high performance under disruptive conditions can be established and maintained. There is an underlying assumption that pervades 'resilience thinking', that a resilient system can be built that will continue to guarantee high performance through all types of disruptive conditions. The constructionist approach to resilience is problematic because many of the 'components' that appear to contribute to resilience are those same components that are already present in many organisations, irrespective of their level of resilience. Many of these organisations which have apparent 'resilience components' in place will demonstrate low resilience when challenged by changing conditions. Can exploring organisational failure reveal more about resilience than can seeking out apparent success?

The presence of a number of factors have been associated with degrading resilience and contributing to organisational failure, even though positive resilience attributes may be present. These include:

- Organisational failure pathologies.
- The contribution of the corporate psychopath.
- Reputational failure.

Organisational failure pathology

Resilience engineering and Safety II thinking promotes the concept that since systems are inherently prone to failure, then safety is achieved by constant attention to addressing potential contributors to that failure. Similar thinking can be applied to the organisational resilience discourse. A starting point is to recognise that 'failure' is already built into the design, development and implementation of most of the systems upon which an organisation relies (Hollnagel, 2018; Dekker, 2015, 2006). These 'built-in failures' along with other failures 'acquired' throughout the life of an organisation constitute a diverse range of pathologies⁴⁵ that can threaten overall organisational health (Pascieczny, 2017) and resilience.

The following organisational pathologies are particularly influential in contributing to degraded resilience:

- Cognitive and emotional pathologies of individuals and groups: where information is processed in a manner that creates misperception, misunderstanding or misapplication of information; or where inappropriate decisions are made. Normalisation of deviance is one outcome of cognitive pathology (see below).
- Mindlessness including a thoughtless disregard of contestable information by decision-makers. This also includes a propensity for many people within an organisation to continue to make the same types of decisions and take the same type of actions despite the growing evidence of their ineffectiveness. Of more concern are those that blindly follow inappropriate plans and processes because inflexible policies and directions, or external (and often inadequate) Standards require it.
- Structural pathologies within hierarchies, where inadequate or inappropriate supervisory or reporting relationships, or misaligned functional responsibilities, etc. create barriers to effective flows of information, sensemaking, decision-making, or taking action.

⁴⁵ Pathologies comprise those organisational aspects that are sources, contributors, influencers, or amplifiers of organisational degradation and failure. Pathologies may be the result of flaws or errors that remain uncorrected (and often unrecognised over prolonged periods of time); inability to apply capabilities where, when, and as required; or inability to make sense of the information to hand within an effective time frame. These pathologies may effect organisational performance under routine conditions, but their effects are likely to be substantially amplified under non-routine operating conditions.

- *Behavioural and cultural pathologies*, where organisational culture adversely effects sensemaking and decisions, resulting in inappropriate behaviours and actions. This also includes flawed decision-making processes that fail to make appropriate use of available information.
- *System and functional pathologies*, where existing systems of work and processes are inherently flawed and may not be fit-for-purpose even under routine conditions, as well as errors and variability acquired over time.
- *Communication and information pathologies*, where both human and technological information flows are impaired or heavily reliant upon ineffective mechanisms, tools and technologies.
- *Infrastructure pathologies*, where either or both internal and external infrastructure is of low reliability or functionality due to capacity, mechanical, technical, physical or structural limitations or flaws.
- *Network pathologies*, where existing relationships are fragile when placed under pressure, including supplier, customer and partner networks.
- *Leadership and team pathologies*, often arising from inadequate competencies, expertise and knowledge, trust, empathy, cohesiveness, etc.
- *Governance pathologies*, including inappropriate, inadequate or absent governance structures, reporting frameworks, ethical and integrity standards, delegations, processes, etc.

Cognitive and emotional pathologies

Common cognitive pathologies that contribute to organisational failure are related to attention, perception, memory and analysis, and their effects on decision-making (Jin et al, 2019; Prezenski et al, 2017, Cokely and Kelley, 2009; Wang and Ruhe, 2007). In particular, these factors can influence decision-making through the biases and heuristics, which can result in non-rational and unpredictable effects on decisions. Similar uncertain effects can arise from different emotional effects that alter perception, how memories are encoded, and how information is analysed and considered.

Over the last decade or so there has been increasing recognition that even under routine conditions, a significant amount of decision-making occurs independently of rational thought processes. The dual processing theory describe how decision-making occurs as a result of the interaction of two thinking systems, one that is analytical: slow, rational and consciously controlled, the other intuitive/emotional: automatic, unconscious and very fast (Stanovich, 2011; Kahneman, 2011; Croskerry, 2009; Evans, 2011; 2007; Stanovich and West, 2000). This results in decisions that can be highly influenced by past knowledge and experiences (especially those with high emotional salience), with this being unrecognised by the decision-maker. When subject to the stress and fatigue of an incident or disruption, the intuitive/emotional system can overwhelm the control of the analytical system, leading to errors of perception and cognition⁴⁶ (Evans, 2008; Kahneman & Frederick, 2005; Buss, 2005; Stanovich and West, 2003; 2000), and resulting in decisions that would not have been made under routine conditions.

Additionally, cognitive capability, including complex problem skills are not at consistently high levels across an organisation. The promotional practices within many organisations tend to favour those with linear thinking and lower cognitive skills, allowing those less able to deal with complex problem solving to preferentially rise to higher management levels (Chamorro-Premizic, 2019; Ryan, 2016; Kohlmann; 2012).

⁴⁶ Under conditions of high stress, hormones such as cortisol are released in increasing amounts, and have a direct effect increasing short term cognitive impairment (Mueller, 2011; Dunn et al, 2009; Storbeck and Clore, 2007),

Mindlessness

Before examining the issues with *mindlessness* in organisations, it is perhaps worth pausing in order to consider the virtues of *mindfulness* and its contribution to enhancing resilience. Mindfulness of the individual has been described as a process of active engagement with the present, and sensemaking of the range of stimulus patterns received by that an individual (Corbett, 2017; Tang, 2017; Moldoveanu, 2016). Mindfulness therefore involves a combination of cognitive and emotional interpretation of context, and making active decisions to change behaviour based upon that interpretation. From an organisational perspective, the mindfulness of leaders begins to play an important role in recognising and dealing effectively with uncertainty, often in new and different ways (Levey and Levey, 2019; Rupprecht et al, 2019; Brendel et al, 2016; Dunoon and Langer, 2012; 2011).

Mindlessness, refers not just to a lack of mindfulness, but to a condition where there is a complete disregard of what is happening, and the thoughtless and almost robotic repetition of routinised scripts and behaviours, irrespective of the effect that they are having (Ashforth and Fried, 1988). Mindlessness is typified by applying prior habitual ‘thinking’ and behaviour to changing situations where they have little application or relevance. On an individual level this brings to mind the antics of the clueless office manager character played by Ricky Gervais in the TV series, ‘The Office’.

Most organisations operate at a certain level of mindlessness in their day-to-day operations. It lets the work get done reasonably quickly and efficiently (although often not effectively), without being constantly questioned and challenged (Heffernan, 2017; Alvesson and Spicer, 2016). This can be a positive attribute in routine conditions that are highly stable, where objectives and capability do not need to adapt to changing conditions. However, with increasing change, the ‘mindlessness mode’ becomes increasingly ill-suited to cope with evolving demands (Langer and Moldoveanu, 2000), and can be a substantial barrier to effective organisational resilience. As well as creating a lack of awareness about an organisation’s context, mindlessness (along with the normalisation of deviance, see below) also contributes to so called ‘absurd decisions’ (Simard and Laberge, 2016), which are persistently made and act directly against the objectives they are supposed to achieve.

Organisational mindlessness appears to be closely associated with the whimsically termed ‘functional stupidity’ (Alvesson and Spicer, 2017) where mindlessness becomes culturally embedded. Functional stupidity is driven by poor organisational leadership, inadequate organisational structures, and often by the blind imitation of other organisations that are perceived to be doing better. Mindlessness (functional stupidity) effectively closes down innovative and adaptive thinking just when it is most required.

Normalisation of deviance

Normalisation of deviance (also manifests as the normalisation of risk) occurs when specific erroneous data, information, decisions, or behaviours are accepted once, and then become a precedent for accepting similar erroneous circumstances in the future (Vaughn, 2016), where that acceptance is carried into very different circumstances. Normalisation of deviance is most commonly seen where someone takes an expedient shortcut in a process (or decision). The shortcut produces a positive outcome and ‘reward’ (e.g. the work is undertaken with less personal effort, or is achieved much more quickly), and with no obvious penalties (e.g. the process does not fail and the operator does not get a reprimand). Later, under comparable circumstances this shortcut is repeated with similar outcomes. This new (aberrant) behaviour is reinforced⁴⁷, with an increased likelihood of it being repeated in the future.

⁴⁷ It is likely that the activation of reward circuit in the brain continually reinforces these accumulating deviant behaviours, increasing the likelihood of their being repeated and becoming habituated.

Eventually this behaviour is normalised and becomes the accepted way of performing the activity. The process has now deviated from its original accepted design. This changed approach can then be shared with others, this normalisation of deviance spreading, as the local variant process is more widely adopted. Over time, additional shortcuts are taken, and under routine conditions can still achieve a satisfactory level of performance. However, this normalisation of deviance has created a more fragile system that will perform in unexpected ways when even slight changes in operating conditions occur.

In a resilience context, this normalisation of deviance (or risk) begins to establish patterns of decision-making and behaviour that can degrade any of the attributes contributing to resilience. Such normalisation is insidious as few recognise that it is occurring at the time, and often do not recognise it in hindsight.

Such normalisation of deviance usually manifests itself in the creation of informal landscapes within most organisation (Figure 23), where local rules and behaviours are the accepted norm, representing very different decision-making and other activities ('work as done') from the formal landscape. The formal landscape comprises: how decision-making and other processes are required to operate ('work as designed'), how senior management thinks these operations are working ('work as imagined'), and what these managers officially reveal about these operations ('work as reported'). Such normalisation of deviance means that systems rarely function as expected, and these informally modified systems are often close to the threshold of failure in routine circumstances, and can collapse rapidly and without warning when conditions change.

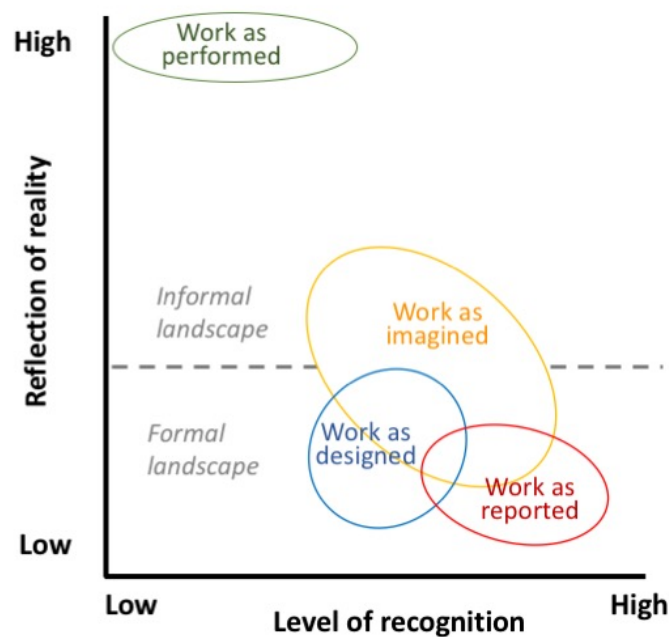


Figure 23: The normalisation of deviance

Gatekeepers and barriers

There are certain positions and individuals within an organisation whose sole purpose (at least in their own minds) is to filter information heading up through the management hierarchy. Often this is the so called 'trusted advisor' who only allows good news to filter up to their boss. Sometimes this is a deliberate power strategy, often it occurs because there is denial, lack of cognitive capability, or inexperience to deal appropriately with the information. The gatekeeper concept also includes those tasked with the 'defence' of the organisation – such as internal and external auditors, (Coffee, 2005)

that through a lack of vigilance or an unwillingness to speak up, prevent management from becoming aware of burgeoning problems. The actions of all types of gatekeepers help to perpetuate uncertainty, and actively encourage ignorance in an organisation's top decision-makers, affecting anticipation, preparedness, response, and recovery.

Strategic relevance and decay

It has been estimated that somewhere between 60% and 90% of all strategy implementation fails (Kaplan and Norton, 2005; Mankins and Steele, 2005), whilst up to 95% of employees either have no idea of their organisation's strategy, or do not really understand it (Kaplan and Norton, 2005). The alignment of employees with organisational strategy can be further degraded by providing incentives that are incompatible with organisational priorities and obligations (Conlon, 2015; Aaron et al, 2014; Lovallo and Sibony, 2010; Filatotchev et al, 2006; Lenchick, 2016). This in particular applies to those incentives that favour short term gains over longer term achievement (Bircham and Connolly, 2013).

Some strategy may be appropriate and achievable, but with an organisation that is misaligned with its strategy, failure may be more likely than success. However, in many organisations even where a good strategy is developed, and the organisation starts to implement it effectively, that strategy can quickly lose its relevance as complexity, turbulence, volatility and uncertainty increase in the operational environment.

When a strategy is increasingly irrelevant to the context and organisational need, an inevitable consequence will be a deterioration in overall resilience. Change and time 'destroys' strategy, and an increasingly irrelevant strategy 'destroys' resilience (Hamel and Välikangas, 2003). The organisation simply will not be prepared to either avoid or deal with the turbulence and shocks that will come its way.

Dark resilience

Resilience, although regarded widely as a strength, may not always be beneficial. Resilience can result in a system remaining in an undesirable, harmful or stagnant state (Mitchell and Harris, 2012), or in a state that is resistant to needed change⁴⁸ (Stares and Wit, 2009). It seems almost counter-intuitive that resilience can have a dark side, but what are seen as individual or organisational strengths for resilience can, if taken too far, become real weaknesses (Figure 24).

For example, adaptive capability, if taken to the extreme, can in itself become maladaptive and harmful (Chamorro-Premizic and Lusk, 2017; Kaplan and Kaiser, 2003). Even leadership traits that are so valuable to resilience, such as versatility and agility, can become substantial liabilities if over indulged (Kaplan and Kaiser, 2013; 2006) and in the longer term could weaken resilience as much as if those beneficial traits were completely absent.

⁴⁸ Such as experienced in a despotic regime.

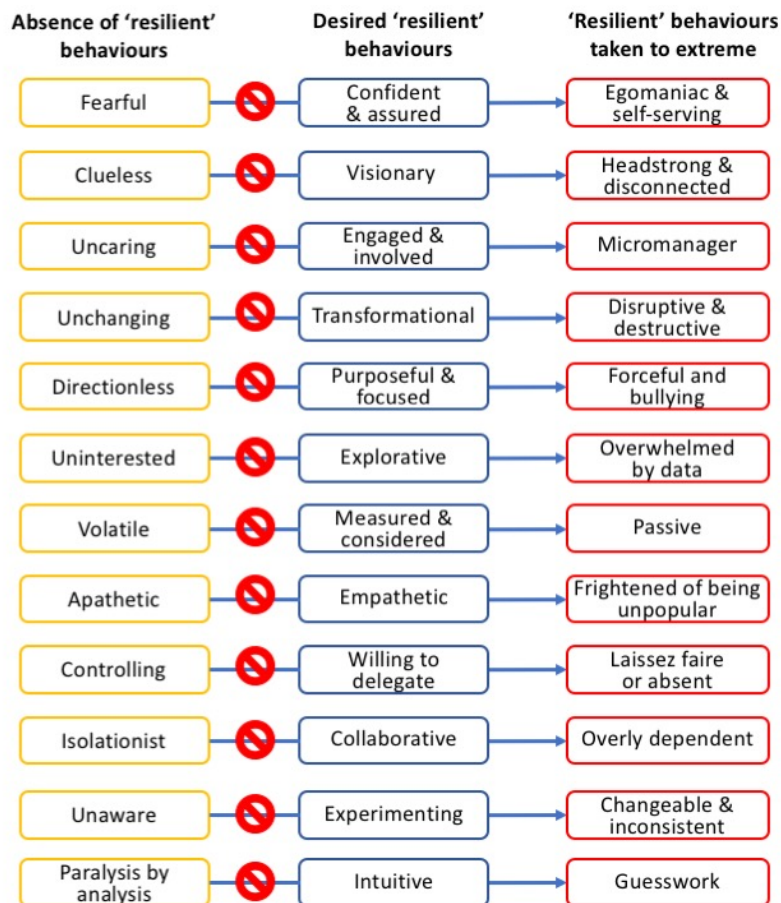


Figure 24: Resilient behaviours taken to extreme

From a psychological aspect, individuals and teams that show initial high personal resilience, often respond unemotionally and aggressively, towards the incumbent stresses. Whilst less resilient individuals may become increasingly self-protective and isolated⁴⁹. However, these same traits that allow the highly resilient individual to continue to perform, may limit self-awareness and cause them to over-estimate their own capabilities in these circumstances (Chamorro-Premizic and Lusk, 2017).

Corporate psychopaths

A corporate psychopath is characterised as an individual that is without conscience or personal ethics, and is self-centred, selfish, manipulative, and ruthless. Corporate psychopaths have been shown to exist in many organisations and at all levels of management (Boddy, 2013, 2011; Boddy et al, 2010). They can be highly successful (hence their significant presence at senior leadership levels), and can cover their psychopathy with a mask that can be sustained for many years. Hence the majority of corporate psychopaths remain undetected and unrecognised (Babiak and O’Toole, 2012; Mathieu et al, 2012; Andrews and Furniss, 2009). The corporate psychopath’s behaviour is driven by a personality disorder, with an estimated 1% of employees and 4% of senior executives with the disorder (Boddy et al, 2010)

⁴⁹ Disruptive and unfamiliar conditions can create psychological stress which drives individuals to over rely on familiar and preferred behaviours, pushing favourable traits into unwanted behaviours.

The existence of such people at senior leadership and decision-making positions poses serious problems for long term organisational performance and for resilience (Gudmundsson and Southey, 2011). Their complete lack of regard for others and for the organisation as a whole means that their decisions will be made solely on the basis of what is best for themselves. In doing so they use techniques such as creating dissent and conflict among other members of the organisation, and using bullying to get their own way. Their behaviour sows distrust, destabilises teams, and contributes to an increasing degradation of long term performance and resilience.

Reputational loss

An organisation may have in place a comprehensive array of recognised attributes that contribute to resilience, yet any failure to protect its reputation can significantly disrupt operations, threaten the tenure of its leadership team, and in some cases, threaten the organisation's very survival (Drenik, 2018; DiPietro, 2016; De Wolf and Meijri 2013; Schultz et al, 2012).

Whilst strengthening recognised 'resilience capabilities' will certainly help protect reputation, this may not be sufficient on its own. Effective issues management (dealing with an impending crisis before it becomes one) and crisis management make vitally important contributions (Vos et al, 2017; London First, 2013;) to both enhancing resilience and to protecting reputation (see Chapter 10). Looking after organisational reputation will certainly positively influence an organisation's resilience into the long term (Tracey and French, 2017).

Bringing it all together - moving towards resilience

To date, there is no single published work that has described the variety of concepts expounded by different domains, and found in different contexts. All resilience models are limited, indeed all models are flawed, being able to capture only a small range of the factors that could influence resilience. The thinking behind these models has been constrained by their ability to grasp only part of the complexity of the real world. Resilience models therefore only provide a two dimensional snapshot of (at least) four dimensional reality, and anyone claiming to have the comprehensive model should be treated with caution. It may be possible to develop such a model with the use of incredibly complex mathematical algorithms within sophisticated software, although such software capability remains to be proven.

However, some of the models we have described in this Monograph do provide useful insights into different aspects of the resilience construct. It is an almost impossible task to cover every aspect of the vast array of published literature on resilience, and by necessity this Monograph has disregarded those that the author believes provide little value. Although there may be some valuable ideas that may have been missed along the journey.

Given all of these provisos, Figure 25 attempts to provide a consolidated model combining the key aspects of those that have gone before, albeit that this model is limited, imperfect, and well frankly "wrong" -but hopefully useful.

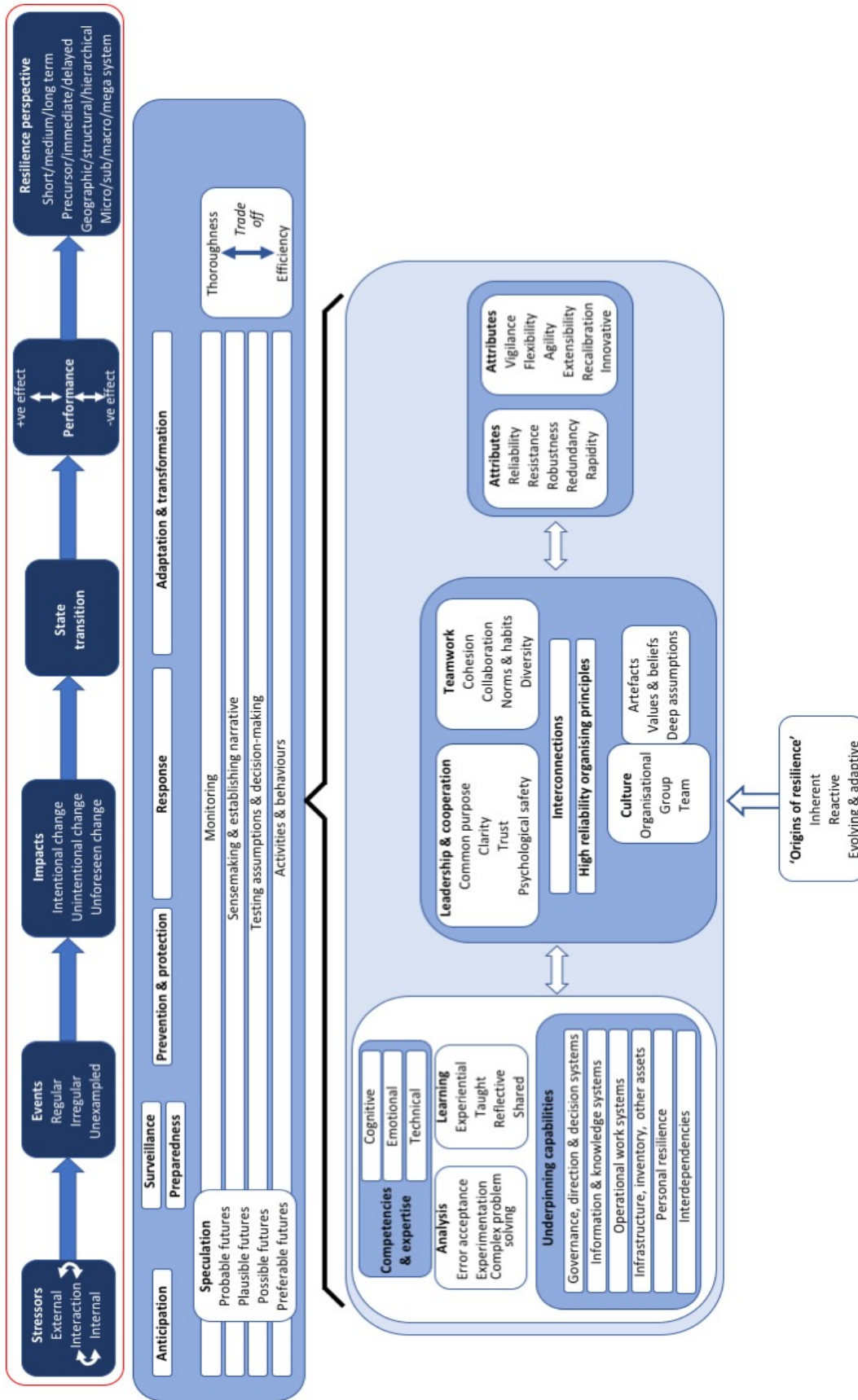


Figure 25: Consolidated resilience model

References

- Aaron J.R., Harris M.L., McDowell W.C., and Cline B.N. (2014). *Optimal CEO Incentive Contracts: A Prospect Theory Explanation*. Journal of Business Strategies 31(2) pp. 46-64.
- Abofalia M.Y. (2010). *Narrative Construction as Sensemaking: How A Central Bank Thinks*. Organization Studies 31(03) pp. 349-367.
- Ackoff R. L. (1971). *Towards a System of Systems Concepts*. Management Science 17(11) pp. 661-671.
- Adamides E.D. and Voutsina M. (2006). *The Double-helix Model of Manufacturing and Marketing Strategies*. International Journal of Production Economics 104 (1) pp. 3-18.
- Adger W.N. (2000). *Social and Ecological Resilience: Are They Related?* Progress in Human Geography 24 (3) pp. 347-364.
- Adger W.N., Hughes T.P., Folke C., Carpenter S.R., and Rockström J. (2005). *Social-Ecological Resilience to Coastal Disasters*. Science 309 pp. 1036-1039.
- Adler A.B. and Saboe K.N. (2017). *How Organisations and Leaders can Build Resilience: Lessons from High Risk Occupations*. In *Managing for Resilience*. In: A Practical Guide for Employee Wellbeing and Organizational Performance, pp. 171-189, (Editor: M.F. Crane), Routledge London, UK.
- Agaibi C.E. and Wilson J.P. (2005). *Trauma, PTSD, and Resilience: A Review of the Literature*. Trauma Violence Abuse 6 pp. 195-216.
- Akgün A.E. and Keskin H. (2013). *Organisational Resilience Capacity and Firm Product Innovativeness and Performance*. International Journal of Production Research 52(23) pp. 6918-6937.
- Albani M. and Henderson K. (2014). *Building Resilience Through Teamwork*. In: *Turbulence: A Corporate Perspective on Collaborating for Resilience* (Editor: Roland Kupers), Amsterdam University Press, Amsterdam, NL.
- Albani M. and Kupers R. (2014). *A Pragmatic Frame to Explore Resilience*. In: *Turbulence: A Corporate Perspective on Collaborating for Resilience* (Editor: Roland Kupers), Amsterdam University Press, Amsterdam, NL.
- Albert M. (1993) *Capitalism vs Capitalism: How America's Obsession with Individual Achievement and Short-term Profit Has Led It to the Brink of Collapse*. Four Walls Eight Windows Publishing, New York, NY.
- Alberti M. (2018). *Cities That Think Like Planets: Complexity, Resilience, and Innovation in Hybrid Ecosystems*. University of Washington Press, Seattle and London.
- Alberts D. S. (2011). *The Agility Advantage: A Survival Guide for Complex Enterprises and Endeavors*. Command and Control Research Program Publication Series, Department of Defense, Washington, DC.
- Alderson D.L. and Doyle J.C. (2010). *Contrasting Views of Complexity and their Implications for Network-centric Infrastructures*. IEEE SMC—Part A. 40 pp. 839-852.
- Alesi P. (2008). *Building Enterprise-wide Resilience by Integrating Business Continuity Capability into Day-to-day Business Culture and Technology*. Journal of Business Continuity and Emergency Planning 2(3) pp. 214-20.
- Allenby B. and Fink J. (2005). *Toward Inherently Secure and Resilient Societies*. Science 309 pp. 1034-1036.
- Alpaslan C.M. and Mitroff I.I. (2004). *Bounded Morality: The Relationship Between Ethical Orientation and Crisis Management, Before and After 9/11*. Current Topics in Management 6 pp. 13-43, JAI Press, Greenwich, UK.
- Alvesson M. and Spicer A. (2016). *The Stupidity Paradox: The Power and Pitfalls of Functional Stupidity at Work*. Profile Books, London UK.
- Ancona D. (2011). *Sensemaking: Framing and Acting in the Unknown*. In: *The Handbook for Teaching Leadership* (Editors: S. Snook, N. Nohria, and R. Khurana), Sage Publications, Thousand Oaks, CA.
- Andrés B. and Poler R. (2013). *Enhancing Enterprise Resilience through Enterprise Collaboration*. IFAC Papers Online 7(1) pp. 688-693.
- Andrews H., and Furniss P. (2009). *A Successful Leader or a Psychopathic Individual?* Management Services 53(4) pp. 22-24.
- Anklam P. (2007). *Net Work: A Practical Guide to Creating and Sustaining Networks at Work and in the World*. Elsevier, Amsterdam, NL.
- Appelbaum S. (1997). *Socio-technical Systems Theory: An Intervention Strategy for Organizational Development*. Management Decision 35(6) pp.452-463.
- APRA (2018). *Prudential Inquiry into the Commonwealth Bank of Australia, April 2018*. Australian Prudential Regulatory Authority.
- Aristotle 1955. *Nicomachean Ethics*. Translated by J. A. K. Thomson. London: Penguin Books.
- Arizzi S., Egger M., Rittenhouse D. and Williams P. (2014). *Corporations and Resilience*. In: *Turbulence: A Corporate Perspective on Collaborating for Resilience* (Editor: R. Kupers), Amsterdam University Press, Amsterdam NL.
- Asbjørnslet B. (2008). *Assessing the Vulnerability of Supply Chains*. In *Supply Chain Risk: A Handbook of Assessment, Management and Performance*, (Editors: G.A. Zsidisin and B. Ritchie). Springer, New York, NY.
- Ashforth B.E. and Fried Y. (1988). *The Mindlessness of Organisational Behaviours*. Human Relations 41(40) pp. 305-329.
- Ashley W.C. and Morrison J. (1996). *Anticipatory Management Tools for the 21st Century*. Futures Research Quarterly 12(2) pp. 35-50.
- Ates A. and Bitici U.S. (2011). *Change Process: A Key Enabler for Building Resilient SMEs*. International Journal of Production Research 49(18) pp. 5601-5618.
- Australian Government (2018). *What is Organisational Resilience?* Accessed on 13 January, 2018, at: www.organisationalresilience.gov.au/Pages/default.aspx.
- Australian Government (2015). *Critical Infrastructure Resilience Strategy*. Australian Government.

- Australian Government** (2012). Research Report 1: CEO Perspectives on Organisational Resilience. Canberra, ACT, Australia.
- Aven T.** (2015). *The Concept of Antifragility and its Implications for the Practice of Risk Analysis*. Risk Analysis 35(3) pp. 476–483.
- Avery G.C.** and Bergensteiner H. (2011). *Sustainable Leadership Practices Enhancing Business Resilience and Performance*. Strategy and Leadership 39(3) pp. 5-15.
- Avizienis A.,** Laprie J.C., Randell B., and Landwehr C. (2004). *Basic Concepts and Taxonomy of Dependable and Secure Computing*. IEEE Transactions on Dependable and Secure Computing 1(1) pp. 11-33.
- Ayala J. C.** and Manzano G. (2014). *The Resilience of the Entrepreneur. Influence on the Success of the Business. A Longitudinal Analysis*. Journal of Economic Psychology 42 pp. 126-135.
- Azusa K.** and Hiroyuki Y. (2013). *Organizational Resilience: An Investigation of Key Factors that Promote the Rapid Recovery of Organizations*. Academic Journal of Interdisciplinary Studies 2(9) pp. 188-194.
- Babiak P.** and O'Toole, M. E. (2012). *The Corporate Psychopath*. FBI Law Enforcement Bulletin 81(11) pp. 7-11.
- Baker M.D.** (2016). *Social Networks and High Healthcare Utilization: Building Resilience Through Analysis*. Thesis, Naval Postgraduate School, Monterey, CA.
- Baker D.P.,** Day R., and Salas E. (2006). *Teamwork as an Essential Component of High-Reliability Organizations*. Health Services Research 41(4) Part II, pp. 1576-1598.
- Barasa E.,** Mbau R., and Gilson L. (2018). *What Is Resilience and How Can It Be Nurtured? A Systematic Review of Empirical Literature on Organizational Resilience*. International Journal of Health Policy Management 7(6) pp. 491-503.
- Barroso H. P.,** Machado V. H., and Machado V. C. (2011). *Supply Chain Resilience Using the Mapping Approach*. In: Supply Chain Management pp. 161-184, (Editor: L. Pengzhong), InTech. Accessed on 16 July 2018 at: <https://www.intechopen.com/books/supply-chain-management/supply-chain-resilience-using-the-mapping-approach>.
- Bartlet K.,** Nolan M., and Marraffino A. (2013). *Intuitive Sensemaking: From Theory to Simulation Based Training*. In: Foundations of Augmented Cognition, (Editors: D.D., Schmorow and C.M. Fidopiastis) AC 2013. Lecture Notes in Computer Science, vol 8027. Springer, Berlin, Heidelberg.
- Bason C.** (2018). *Leading Public Sector Innovation: Co-creating for a Better Society*. Policy Press, Bristol, UK.
- Batorski J.** (2011). *Fragmentation of Crisis Management in an Enterprise*. Serbian Journal of Emergency Management 6(2) pp. 283-286.
- Bauweraerts J.** (2016). *How Do Family Firms Manage Risky Situations? An Organizational Resilience Perspective*. International Business Research 9(50) pp. 1-10.
- Begun J.W.** (2002). *Health Care Organizations as Complex Adaptive Systems*. Thesis, University of Minnesota, Minneapolis, MN.
- Bell S.** (2007). *Deep-level Composition Variables as Predictors of Team Performance*. Journal of Applied Psychology 92(3) pp. 595-615.
- Belmonte F.,** Schön W., Heurley L., and Capel R. (2010). *Interdisciplinary Safety Analysis of Complex Socio-technological Systems based on the Functional Resonance Accident Model: An Application to Railway Track Supervision*. Reliability Engineering and System Safety 96 pp. 237-249.
- Bennet N.,** Wise C., Woods P., and Harvey J.A. (2003). *Distributed Leadership: Full Report*. National College for School Leadership, Nottingham, UK.
- Bergström J.,** Dahlström N., Dekker S., and Petersen K. (2011). *Training Organisational Resilience in Escalating Situations*. In: Resilience Engineering in Practice pp. 45-56, (Editors: E. Hollnagel, J. Pariès, D. Woods, J. Wreathall). CRC Press, London, UK.
- Berkes F.** and Folke C. (1998). *Linking Sociological and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge University Press, New York, NY.
- Berthod O.,** Grothe-Hammer M., Müller-Seitz G., Raab J., and Sydow J. (2017). *From High-Reliability Organizations to High-Reliability Networks: The Dynamics of Network Governance in the Face of Emergency*. Journal of Public Administration Research And Theory 27(2) pp. 352-371.
- Bircham J.S.** and Connolly H.J. (2013), *Addicted to Performance: Society Demands More for Less*. BG Publishing, Tuaranga, NZ.
- Bigley G.A.** and Roberts K.H. (2001). *The Incident Command System: High-reliability Organizing for Complex and Volatile Task Environments*. The Academy of Management Journal 44(6) pp. 1281-1299.
- Birkie S.E.,** Trucco P., and Kaulio M. (2014). *Disentangling Core Functions of Operational Resilience: A Critical Review of Extant Literature*. International Journal of Supply Chain and Operations Resilience 1(1) pp. 76-103.
- Björck F.,** Henkel M., Stirna J., and Zdravkovic J. (2015). *Cyber Resilience – Fundamentals for a Definition*. In *New Contributions in Information Systems and Technologies*. Advances in Intelligent Systems and Computing, 353. pp. 311-316 (Editors: A. Rocha, A. Correia, S. Costanzo, L. Reis,). Springer, Cham, Switzerland.
- Bland J.** and Westlake S. (2013). *Stop Thinking About Tomorrow: A Modest Defence of the Futurology*. Nesta, London, UK.
- Boddy C. P.** (2013). *Corporate Psychopaths*. Journal of Corporate Citizenship 49 pp. 8-16.
- Boddy C.R.** (2011). *The Corporate Psychopaths Theory of the Global Financial Crisis*. Journal of Business Ethics 102(2) pp. 255-259.
- Boddy C.R.P.,** Ladyshevsky R., and Galvin P. (2010). *Leaders Without Ethics in Global Business: Corporate Psychopaths*. Journal of Public Affairs 10(3) pp. 121-138.
- Böggemann M.** and Both N. (2014). *The Resilience Action Initiative: An introduction*. In: Turbulence: A Corporate Perspective on Collaborating for Resilience (Editor: Roland Kupers), Amsterdam University Press, Amsterdam NL.

- Bohn** J.G. and **Grafton** W.I. (2002). *The Relationship of Perceived Leadership Behaviours to Organizational Efficiency*. The Journal of Leadership and Organization Studies 9(1) pp. 65-79.
- Boin** A., and **t'Hart** P. (2010). *Organising for Effective Emergency Management: Lessons from Research*. Australian Journal of Public Administration 69 pp. 357-371.
- Boin** A., **Comfort** L.K., and **Demchak** C.C. (2010). *The Rise of Resilience*. In *Designing Resilience: Preparing for Extreme Events* pp. 1–12. (Editors: L. K. Comfort, A. Boin, and C. C. Demchak). University of Pittsburgh Press, Pittsburgh, PA.
- Boin** A. and **van Eeten** M.J.G. (2013). *The Resilient Organisation*. Public Management Review 15(3) pp. 439-445.
- Boin** A. and **McConnell** A. (2007). *Preparing for Critical Break-downs: The Limits of Crisis Management and the Need for Resilience*. Journal of Contingencies and Crisis Management 15 pp. 50–59.
- Bonanno** G.A. (2004). *Loss, Trauma, and Human Resilience: Have we Underestimated the Human Capacity to Thrive after Extremely Aversive Events?* American Psychologist 59(1) pp. 20–28.
- Bonanno** G.A., **Brewin** C.R., **Kaniasty** K., and **La Greca** A.M. (2010). *Weighing the Costs of Disaster : Consequences, Risks, and Resilience in Individuals, Families, and Communities*. Psychological Science in the Public Interest 11(1) pp. 1–49.
- Bostrom** A. **Böhm** G., **O'Connor** R.E., **Hanss** D., **Bodi-Fernandez** O. and **Halder** P. (2020). *Comparative Risk Science for the Coronavirus Pandemic*. Journal of Risk Research, DOI: 10.1080/13669877.2020.1756384
- Botla** L. (2009). *Systems Thinking: the Gandhian Way*. Journal of Human Values 15(1) pp. 77-90.
- Bourbeau** P. (2013). *Resiliencism: Premises and Promises in Securitisation Research*. Resilience, 1(1) pp. 3–17.
- Box** G.E.P. and **Draper** N.R. (1987). *Empirical Model-Building and Response Surfaces*. Wiley Series in Probability and Mathematical Statistics. John Wiley and Sons Inc., Hoboken, NJ.
- Boyd** E., **Nykvist** B., **Borgström** S., and **Stacewicz** I. A. (2015). *Anticipatory Governance for Social-ecological Resilience*. AMBIO 44(Suppl. 1) pp. S149-S161.
- Bozza** A., **Asprone** D., and **Manfredi**, G. (2015). *Developing an Integrated Framework to Quantify Resilience of Urban Systems Against Disasters*. Natural Hazards 78 pp. 1729–1748.
- Bozzon** A., **Brambilla** M., **Ceri** S., **Silvestri** M., and **Vesci** G. (2013). *Choosing the Right Crowd: Expert Finding in Social Networks*. Proceedings of the 16 International Conference on Extending Database Technology pp. 637-648. Genoa, Italy, 18-20 March 2013.
- Braithwaite** J., **Churruca** K., **Ellis** L.A., **Long** J., **Clay-Williams** R., **Damen** N., **Herkes** J., **Pomare** C., and **Ludlow** K. (2017). *Complexity Science in Healthcare – Aspirations, Approaches, Applications and Accomplishments: A White Paper*. Australian Institute of Health Innovation, Macquarie University, Sydney, NSW, Australia.
- Branicki** L., **Steyer** V., and **Sullivan-Taylor** B. (2019). *Why Resilience Managers Aren't Resilient, and What Human Resource Management Can Do About it*. The International Journal of Human Resource Management 30(8) pp. 1261-1286.
- Brehmer** B. and **Allard** R. (1991). *Dynamic Decision Making: The Effects of Task Complexity and Feedback Delay*. In: *New Technologies and Work. Distributed Decision Making: Cognitive Models for Cooperative Work* pp. 319–334 (Editors: J. Rasmussen, B. Brehmer, and J. Leplat). John Wiley and Sons, New York, NY.
- Brendel** W., **Hankerson** S., **Byun** S., **Cunningham** B. (2016). *Cultivating Leadership Dharma*. Journal of Management Development 35(8) pp. 1056 – 1078.
- Bresch** D.N., **Berguijs** J., **Egloff** R., and **Kupers** R. (2014). *A Resilience Lens for Enterprise Risk Management*. In: *Turbulence: A Corporate Perspective on Collaborating for Resilience* (Editor: R. Kupers), Amsterdam University Press, Amsterdam NL.
- Brewer** J. (2014). *Mindfulness in the Military*. American Journal of Psychiatry 171(8) pp. 803-806.
- Briguglio** L., **Cordina** G., **Farrugia** N., and **Vella** S. (2009). *Economic Vulnerability and Resilience: Concepts and Measurements*. Oxford Development Studies 37(3) pp. 229-247.
- Bristow** G. and **Healy** A. (2018). *Innovation and Regional Economic Resilience: An Exploratory Analysis*. The Annals of Regional Science 60(2) pp. 265-284.
- Britt** T.W., **Shen** W., **Sinclair** R.R., **Grossman** M.R., and **Klieger** D.M. (2016). *How Much Do We Really Know About Employee Resilience?* Industrial and Organizational Psychology 9(2) pp. 378 – 404.
- Bryce** C. **Ring** P. **Ashby** S. and **Wardman** J.K. (2020). *Resilience in the Face of Uncertainty: Early Lessons from the COVID-19 Pandemic*. Journal of Risk Research DOI: 10.1080/13669877.2020.1756379.
- Brueller** D., **Brueller** N.N., **Brueller** R., and **Carmeli** A. (2019). *Interorganisational Relationships in Times of Decline: Implications for Organisational Resilience*. Applied Psychology: An International Review 68(4) pp.715-758.
- Bruneau** M., **Chang** S.E., **Eguchi** R.T., **Lee** G.C., **O'Rourke** T.D., **Reinhorn** A.M., **Shinouzuka** M., **Tierney** K., **Wallace** W.A., and **von Winterfeldt** D. (2003). *A Framework to Quantitatively Assess and Enhance the Seismic Resilience of Communities*. Earthquake Spectra 19 (4) pp. 733–752.
- Bruneau** M. and **Reinhorn** A. (2007). *Exploring the Concept of Seismic Resilience for Acute Care Facilities*. Earthquake Spectra 23(1) pp. 41–62.
- Buckle** P., **Mars** G., and **Smale** S. (2000). *New Approaches to Assessing Vulnerability and Resilience*. Australian Journal of Emergency Management 15(2) pp. 8.
- Burby** R.J. (2006). *Hurricane Katrina and the Paradoxes of Government Disaster Policy: Bringing About Wise Governmental Decisions for Hazardous Areas*. The Annals of the American Academy of Political and Social Science 604 pp. 171-191.
- Burnard** K. (2016). *Achieving a Resilient Response to Crisis: A Case Study from the Pharmaceutical Industry*. Proceedings of the 27th Annual POMS Conference, Orlando FL, May 2016.
- Burnard** K. and **Bhamra** R. (2011). *Organisational Resilience: Development of a Conceptual Framework for Organisational Responses*. International Journal of Production Research, 49(18) pp. 5581-5599.

- Burnard K., Bhamra R. and Tsinopoulos C. (2018)** *Building Organisational Resilience: Four Configurations*. IEEE Transactions on Engineering Management 65(3) pp. 351-362.
- Burnes B., Hughes M., and By R.T. (2016).** *Reimagining Organisational Change Leadership*. Leadership 14(2) pp. 141-158.
- Cabinet Office (2005).** *Dealing with Disaster*, 3rd edition. Cabinet Office, London UK.
- Cabinet Office (2011).** *Keeping the Country Running: Natural Hazards and Infrastructure*. Cabinet Office, London UK.
- Carley K.M. and Harrald J.R. (1997).** *Organizational Learning Under Fire: Theory and Practice*. American Behavioural Scientist 40(3) pp. 310-332.
- Carlisle Y.M. and McMillan E. (2017).** *Complex Adaptive Systems and Strategy as Learning*. In: Global Innovation and Entrepreneurship (Editors: S. Little, F. Go, and T.C. Poon), Palgrave Macmillan, Cham, Switzerland.
- Carlson J.M., Doyle J. (2002).** *Complexity and Robustness*. Proceedings of the National Academy of Sciences 99(s1) pp. 2545
- Carmeli A., Friedman Y., and Tishler A. (2013).** *Cultivating a Resilient Top Management Team: The Importance of Relational Connections and Strategic Decision Comprehensiveness*. Safety Science 51 pp. 148-159.
- Carpenter S.R. and Brock W.A. (2008).** *Adaptive Capacity and Traps*. Ecology and Society 13(2) pp. 40-56.
- Carthey J., de Leval M.R., and Reason J.T. (2001).** *Institutional Resilience in Health Systems*. Quality in Health Care 10 pp. 29-32.
- Cascio J. (2009).** *The Next Big Thing: Resilience*. Foreign Policy 28 September, 2009.
- Casler J.G. (2014).** *Revisiting NASA as a High Reliability Organization*. Public Organizational Review 14 pp. 229-244.
- Chamorro-Premizic T. (2019).** *Why Do So Many Incompetent Men Become Leaders*. Harvard University Press, Boston, MA.
- Chamorro-Premizic T. and Lusk L. (2017).** *The Dark Side of Resilience*. Harvard Business Review, 16 August 2017.
- Chand A.M. and Loosemore M. (2012).** *Hospital Facility Resilience: An Adaptation Framework for Extreme Weather Events*. Proceedings of the 28th Annual Association of Researchers in Construction Management Conference, 3-5 September 2012, Edinburgh, UK, pp. 101-110.
- Chandra A., Acosta J.D., Meredith L.S., Sanches K., Howard S., Uscher-Pines L., Williams M.V., and Yeung D. (2010).** *Understanding Community Resilience in the Context of National Health Security: A Literature Review*. Rand Health Working Paper Series. Rand Corporation, Santa Monica CA.
- Chandra A., Acosta J., Stern S., Uscher-Pines L., Williams M.V., Yeung D., Garnett J., and Meredith L.S. (2011).** *Building Community Resilience to Disasters: A Way Forward to Enhance National Health Security*. Rand Corporation, Santa Monica CA.
- Chandra A., Charles A., Hung P., Lopez A., Magaña A., Rodriguez Y., and Williams M. (2014).** *Resilience Builder: Tools for Strengthening Disaster Resilience in Your Community*. Los Angeles County Community Disaster Resilience Project.
- Chang S.E. and Falit-Baiamonte A. (2003).** *Disaster Vulnerability of Businesses in the 2001 Nisqually Earthquake*. Environmental Hazards 4 pp. 59-71.
- Chassin M.R. and Loeb J.M. (2013).** *High Reliability Health Care: Getting There from Here*. The Milbank Quarterly 91(3) pp. 459-490.
- Chen J., Chen T.H.Y., Vertinsky I., Yumagulova L., and Park C. (2013).** *Public-Private Partnerships for the Development of Disaster Resilient Communities*. Journal of Contingencies and Crisis Management 21(3) pp. 130-143.
- Chmutina K., Lizarralde G., Dainty A., and Bosher L. (2016).** *Unpacking Resilience Policy Discourse*. Cities 58 pp. 70-79.
- Chopra S.S., Dillon T., Bilec M.M., Khanna V. (2016).** *A Network-based Framework for Assessing Infrastructure Resilience: A Case Study of the London Metro System*. Journal of the Royal Society Interface 13 Article:: 20160113.
- Chourides P., Longbottom D., and Murphy W. (2003).** *Excellence in Knowledge Management: An Empirical Study to Identify Critical Factors and Performance Measures*. Measuring Business Excellence 7(2) pp. 29-45.
- Christensen C. (2016).** *Organisational Risk Resilience: Risk Assessments' Contribution to Organisational Precursor Resilience*. Master Thesis, University of Stavanger, Norway.
- Christmann G., Ibert O., Kilper H., and Moss T. (2012).** *Vulnerability and Resilience from a Socio-Spatial Perspective: Towards a Theoretical Framework*. Working Paper, Leibniz Institute for Regional Development and Structural Planning, Erkner, Germany.
- Christopher M. and Peck H. (2004).** *Building the Resilient Supply Chain*. International Journal of Logistics Management 15(2) pp. 1-14.
- Christopherson S., Michie J., and Tyler P. (2010).** *Regional Resilience: Theoretical and Empirical Perspectives*. Cambridge Journal of Regions, Economy and Society 3(1) pp. 3-10.
- Christianson M.K., Sutcliffe K.M., Miller M.A., and Iwashyna T.J. (2015).** *Becoming a High Reliability Organisation*. Critical Care 15 Article 314.
- Clarke J., Coaffee J., Rowlands R., Finger J., Hasensein S. and Siebold U. (2015).** *Resilience Evaluation and SOTA Summary Report*. Realising European Resilience for Critical Infrastructure, Horizon 2020 Programme, European Union.
- Coffee J.C. (2005).** *Gatekeeper Failure and Reform: The Challenge of Fashioning Relevant Reforms*. In Corporate Governance in Context: Corporations, States, and Markets in Europe, Japan and the US, (Editors: K. J. Hopt, E. Wymeersch, H. Kanda, and H. Baum), Oxford University Press, Oxford, UK.
- Cokely E.T., and Kelley C.M. (2009).** *Cognitive Abilities and Superior Decision Making Under Risk: A Protocol Analysis and Process Model Evaluation*. Judgement and Decision Making 4(1) pp. 20-33.
- Colding J., Barthel S., and Sorqvist (2019).** *Wicked Problems of Smart Cities*. Smart Cities 2 pp. 512-521.
- Comfort L.K., Namkyung O., Ertan G., and Scheinert S. (2010).** *Designing Adaptive Systems for Disaster Mitigation and Response: The Role of Structure*. In: Designing Resilience: Preparing for Extreme Events, p.p. 33-61 (Editors: L.K. Comfort, A. Boin, and C.C. Demchack) University of Pittsburgh Press, Pittsburgh, PA.

- Comfort** L.K., Sungu Y., Johnson D., and Dunn M. (2001). *Complex Systems in Crisis: Anticipation and Resilience in Dynamic Environments*. Journal of Contingencies and Crisis Management 9(3) pp. 144–158.
- Conerly** B. (2018). *Promoting Wrong people Hurts Employee Retention and Productivity*. Forbes 19 June 2018.
- Conklin** E.J. (2002). *Making Sense of Fragmentary Information: Compendium and the Intelligence Community*. CogNexus Institute, Napa, CA.
- Conlon** G. (2015). *Organizational Alignment Succeeds or Fails Through Incentives*. Data Strategy Technology. Accessed on 25 July 2018 at: <https://www.dmnews.com/customer-experience/blog/13042607/organizational-alignment-succeeds-or-fails-through-incentives>.
- Connelly** E.B., Allen C.R., Hatfield K., Palma-Oliveira J.M, Woods D.D, and Linkov I. (2017). *Features of Resilience*. Environment Systems and Decisions. 37(1) pp. 46-50.
- Conner** D.R. (1998). *Leading at the Edge of Chaos: How to Create the Nimble Organisation*. John Wiley and Sons Inc, Hoboken, NJ.
- Conway** G. (2008). *The Science of Climate Change in Africa: Impacts and Adaptation*. Accessed on 28 February 2018 at: https://www.researchgate.net/publication/267305891_The_Science_of_Climate_Change_in_Africa_Impacts_and_Adaptation.
- Cooke** P. (2018). *Transversality, Resilience and Innovation: A Qualitative Regional Analysis*. In: Resilience Crisis and Innovation (Editors: Baycan T. and Pinto H.). Edward Elgar Publishing, Cheltenham, UK.
- Corbett** K. (2017). *Mindfulness and its Impact on Health and Safety*. American Society of Safety Engineers, Professional Development Conference and exposition, 19-22 June, Denver CO, USA.
- Corey** C.M. and Deitch E.A. (2011). *Factors Affecting Business Recovery Immediately After Hurricane Katrina*. Journal of Contingencies and Crisis Management 19(3) pp. 169-181.
- Coutu** D. (2002). *How Resiliency Works*. Harvard Business Review 80(5) pp. 46-55.
- Cox** R.S. and Hamlen M. (2015). *Community Disaster Resilience and the Rural Resilience Index*. American Behavioral Scientist 59(2) pp. 220-37.
- Craig** R.K. (2019). *Resilience Theory and Wicked Problems*. Policy and Society 38(2) pp. 167-179.
- 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(1) pp. 131–156.
- Crichton** M.T., Ramsay C.G., Kelly T. and Street D. (2009). *Enhancing Organisational Resilience through Emergency Planning: Learnings from Cross-Sectoral Lessons*. Journal of Contingencies and Crisis Management 17(1) pp. 24-37.
- Croskerry** P. (2009). *Clinical Cognition and Diagnostic Error: Applications of a Dual Process Model of Reasoning*. Advances in Health Science Education 14 pp. 27-35.
- Crowley** M.C. (2015). *How the Wrong People Get Promoted and How to Change It*. Fast Company 29 April, 2015.
- Cuesta** F.A., Sequeiros P.G., and Rojo A.L. (2016). *Exploring the Topological Sources of Robustness Against Invasion in Biological and Technological Networks*. Scientific Reports 6, Article number 20666.
- Cutter** S. L., Barnes L., Berry M., Burton C., Evans E., Tate E. and Webb J. (2008a). *A Place-based Model for Understanding Community Resilience to Natural Disasters*. Global Environmental Change 18 pp. 598–606.
- Cutter** S.L., Barnes L., Berry M., Burton C., Evans E., Tate E., and Webb J. (2008b). *Community and Regional Resilience: Perspectives from Hazards, Disasters, and Emergency Management*. CARRI Research Report 1, Community and Regional Resilience Institute, Washington, DC.
- Cutter** S.L., Burton C.G., and Emrich C.T. (2010). *Disaster Resilience Indicators for Benchmarking Baseline Conditions*. Journal of Homeland Security and Emergency Management 7(1) Article 51.
- Dahlhamer** J.M. and Reshaur L. (1996). *Businesses and the 1994 Northridge Earthquake: An Analysis of Pre- and Post-Disaster Preparedness*. Annual Meeting of the Eastern Sociological Society, Boston, MA.
- Dalziel** E.P. and McManus S.T. (2004). *Resilience, Vulnerability, and Adaptive Capacity: Implications for System Performance*. International Forum for Engineering Decision Making (IFED) December 6-8 2004, Stoops, Switzerland.
- Damos** D.L. and Weissmuller J. (2011). *KSAOs for Military Pilot Selection: A Review of the Literature*. Air Force Personnel Center Strategic Research and Assessment. Randolph AFB TX.
- Dane** E. (2011). *Paying Attention to Mindfulness and its Effects on Task Performance in the Workplace*. Journal of Management 37 pp. 997-1018.
- Darling** E.S. and Côté I.M. (2016). *Seeking Resilience in Marine Ecosystems*. Science 359(6379) pp. 986-987.
- Daskon** C.D. (2010). *Cultural Resilience—The Roles of Cultural Traditions in Sustaining Rural Livelihoods: A Case Study from Rural Kandyan Villages in Central Sri Lanka*. Sustainability 2 pp. 1180-11.
- Davidson** J.L., Jacobson C., Lyth A., Dedekorkut-Howes A., Baldwin C.L., Ellison J.C., Holbrook N.J., Howes M.J., Serrao-Neumann S., Singh-Peterson L., and Smith T. (2016). *Interrogating Resilience: Toward a Typology to Improve its Operationalization*. Ecology and Society 21(2): 27.
- Davoudi** S., Shaw K., Haider L.J., Quinlan A.E., Peterson G.D., Wilkinson C., Funfgeld H., McEvoy D., and Porter L. (2012) *Resilience: A Bridging Concept or a Dead End? “Reframing” Resilience*. Planning Theory & Practice 13(2) pp. 299-333.
- Davoudi** S., Brooks E., and Mehmood A. (2013). *Evolutionary Resilience and Strategies for Climate Adaptation*. Planning Practice & Research 28(3) pp. 307-322.
- De Bruijne** M., Comfort A., and van Eeten M. (2010). *Resilience: Exploring its Concept and Meanings*. In: Designing Resilience: Preparing for Extreme Events pp. 13-32 (Editors: L.K. Comfort, A. Boin, C.C. Demchak), University of Pittsburgh Press, Pittsburgh, Pennsylvania, PA.

- De Florio V.** (2016). *A Few Reflections on the Quality of Emergence in Complex Collective Systems*. In *Advances in Complex Societal, Environmental and Engineered Systems* (Editors: M. Essaïdi and M. Nemiche), Springer series "Nonlinear Systems and Complexity", Springer, New York, NY.
- De Florio V.** (2014). *Antifragility = Elasticity + Resilience + Machine Learning Models and Algorithms for Open System Fidelity*. *Procedia Computer Sciences* 32 pp. 834–841.
- De Kraker J.** (2017). *Social Learning for Resilience in Social-ecological Systems*. *Current Opinion in Environmental Sustainability* 28 pp. 100-107.
- Dennett D.C.** (2014). *Intuition Pumps and Other Tools for Thinking*. WW Norton and Co., New York NY.
- Dekker S.** (2015). *Safety Differently: Human Factors for a New Era*. CRC Boca Raton FL.
- Dekker S.** (2006). *The Field Guide to Understanding Human Error*. Ashgate Publishing Ltd, Farnham, UK.
- Dekker S.W.A.** and **Woods D.D.** (2010). *The High Reliability Organization Perspective*. In: *Human Factors in Aviation*, 2nd Edition pp. 123-143 (Editors: E. Salas and D. Maurino), Academic Press Books, Cambridge, MA.
- Derrisen S.** (2014). *Managing Ecological-economic Systems under Uncertainty: from Concepts to Contracts*. Dissertation, Aus dem Institut für Agrarökonomie der Christian-Albrechts-Universität zu Kiel, Germany.
- DeVereuil G.** and **Golubchikov O.** (2016). *Can Resilience be Redeemed? Resilience as a Metaphor For Change, Not Against Change*. *City* 20(2) pp. 143-151.
- De Wolf D.** and **Mejri M.** (2013). *Crisis Communication Failures: The BP Case Study*. *International Journal of Advances in Management and Economics* 2(2) pp. 48-56.
- Dickens P.M.** (2015). *Factors that Facilitate Organisational Change in Complex Systems*, *International Journal of Design and Nature and Ecodynamics* 10(3) pp. 252-260.
- DiPietro B.** (2016). *Crisis of the Week: Fake Accounts Scandal Rocks Wells Fargo*. *Wall Street Journal*, 19 September 2016.
- D’Lima M.** and **Medda F.** (2015). *A New Measure of Resilience: An Application to the London Underground*. *Transportation Research Part A* 81 (5) pp. 35–46.
- Dobrygowski D.** (2016). *Cyber Resilience: Everything You (Really) Need to Know*. World Economic Forum, Geneva Switzerland.
- DOD** (2017). *HRO Corner: Learning to Accelerate High Reliability Transformation*. Official Website of the Military Health System. Accessed on 15 February 2018 at: <https://health.mil/News/Articles/2017/04/30/HRO-Corner-Learning-to-Accelerate-High-Reliability-Transformation>
- Dominguez S.** and **Patricia A.** (2016). *Business Continuity Management: A Holistic Framework for Implementation*. *Culminating Projects in Information Assurance*. Paper 7. Cloud State University.
- Dongxia L.** and **Kan S.,** (2011). *Research on Connotation and Implication of Organizational Resilience- A Comparison Perspective*. In: *International Conference on Management and Service Science (MASS)*, 12-14 August 2011, Beijing, China: IEEE, pp. 1-4.
- Dosi G.** and **Marengo L.** (2007). *Perspective-on the Evolutionary and Behavioral Theories of Organizations: A Tentative Roadmap*. *Organization Science* 18(3) pp. 491–502.
- Downer J.** (2011). *“737-Cabriolet”: The Limits of Knowledge and the Sociology of Inevitable Failure*. *American Journal of Sociology* 117(3) pp. 725-762.
- Drenik G.** (2018). *The Facebook Crisis That Didn’t Need to be*. *Forbes* 3 April, 2018. Accessed on 6 April at: <https://www.forbes.com/sites/forbesinsights/2018/04/03/the-facebook-crisis-that-didnt-need-to-be/#3e70d05f3665>
- Drew G.** (2009). *Leadership and Organisational Culture: Can the CEO and Senior Executive Teams in Bureaucratic Organisations Influence Organisational Culture?* *Academic Leadership the Online Journal* 7(1) pp. 1-8.
- Drury D.** (2013). *Organisational Leadership (1). – Tone and Culture*. *Forbes* 4 July 2013.
- Duchek S.,** **Raetze S.,** and **Scheuch I.** (2019). *The Role of Diversity in Organizational Resilience: A Theoretical Framework*. *Business Research* <https://doi.org/10.1007/s40685-019-0084-8>.
- Duijnhoven H.** and **Neef M.** (2015). *Disentangling Wicked Problems: A Reflexive Approach Towards Resilience Governance*. In: *Applications of Systems Thinking and Soft Operations Research in Managing Complexity* (Editor: A.J. Massey). Springer, Cham, Switzerland.
- Dunn B.D.,** **Billotti D.,** **Murphy V.,** and **Dalgleish T.** (2009). *The Consequences of Effortful Emotion Regulation When Processing Distressing Material: A Comparison of Suppression and Acceptance*. *Behavioural Research and Therapy* 47(9) pp. 761–773.
- Dunoon D.** and **Langer E.** (2012). *Mindful Leadership Communication: Three Keys for Action*. *Training and Development* 39(3) pp. 12-14.
- Dunoon D.** and **Langer E.** (2011). *Mindfulness and Leadership: Opening up to Possibilities*. *Integral Leadership Review* 11(5).
- Duit A.,** **Galaza V.,** **Eckerberga K.,** and **Ebbesson J.** (2010). *Governance, Complexity, and Resilience*. *Global Environmental Change* 20(3) pp. 363–368.
- Dyer C.** (2001). *Bristol Inquiry: Bristol Inquiry Condemns Hospital’s “Club Culture”*. *British Medical Journal* 323(7306) pp. 181-182.
- Dyer L.** and **Schafer R.** (2003). *Dynamic Organisations: Achieving Marketplace and Organizational Agility with People*. In *Leading and Managing People in the Dynamic Organization* (Editors: R.S. Peterson and E.A. Mannix), *Lea’s Organization and Management Series*, Lawrence Erlbaum Associates Publishers, Mahwah, NJ.
- Dyer J.,** and **Singh H.** (1998). *The Relational View: Cooperative Strategy and Sources of Interorganizational Competitive Advantage*. *Academy of Management Review* 23(4) pp. 660-679.
- Eachus P.** (2014). *Community Resilience: Is it Greater than the Sum of the Parts of Individual Resilience?* *Procedia Economics and Finance* 18 pp. 345 – 351.

- Eisenman D.**, Chandra A., Fogelman S., Magana A., Hendricks A., Wells K., Williams M., Tang J., and Plug A. (2014). *The Los Angeles County Community Disaster Resilience Project — A Community-Level, Public Health Initiative to Build Community Disaster Resilience*. *International Journal of Research in Public Health* 11 pp. 8475-8490.
- Ellis B.** and Herbert S.I. (2011). *Complex Adaptive Systems (CAS): An Overview of Key Elements, Characteristics and Application to Management Theory*. *Informatics in Primary Care* 19 pp. 33-37.
- Elmqvist T.** (2014). *Sustainability and Resilience Differ*. *Nature (Correspondence)* 546 pp. 352.
- Endsley M.R.**, and Bolstad C.A. (1994). *Individual Differences in Pilot Situation Awareness*. *The International Journal of Aviation Psychology* 4(3) pp. 241-264.
- ENISA** (2011). *Enabling and Managing End to End Resilience*. European Network and Information Security Agency.
- Enya A.**, Pillay M., and Dempsey S. (2018). *A Systematic Review on High Reliability Organisational Theory as a Safety Management Strategy in Construction*. *Safety* 4 Article 6.
- Erol O.**, Henry D., Sauser B., and Mansouri M. (2010). *Perspectives on Measuring Enterprise Resilience*. *Proceedings of the 4th Annual IEEE International Systems Conference* pp. 587 - 592.
- Evans J.St.B.T.** (2011). *Dual-process Theories of Reasoning: Contemporary Issues and Developmental Applications*. *Developmental Review* 31 pp. 86–102.
- Evans J.St.B. T.** (2008). *Dual-processing Accounts of Reasoning, Judgment, and Social Cognition*. *Annual Review of Psychology* 59 pp. 61–624.
- Evans J.St.B.T.** (2007). *Hypothetical Thinking. Dual Processes in Reasoning and Judgement*. Psychology Press, Taylor and Francis, New York, NY.
- Evans V.**, Cregan K. and Wall T. (2019). *Organizational Resilience and Sustainable Development*. In: *Encyclopedia of the United Nations Sustainability Goals: Good Health & Wellbeing*. (Editor: W.L. Filho), Springer, Cham, Switzerland..
- Falasca M.**, Zobel C.W., and Cook D. (2008). *A Decision Support Framework to Assess Supply Chain Resilience*. *Proceedings of the 5th International ISCRAM Conference* (Editors: F. Fiedrich and B. Van De Walle), May 2008, Washington, DC.
- Farrell P.S.E.** and Connell D. (2010). *Organizational Agility*. In: *The Evolution of C2*. 15th ICCRTS Santa Monica, California, June 22-24; 2010.
- Farrell P. S. E.**, Baisini C., Belanger M., Henshaw M., Mitchell W., and Norlander A. (2013). *SAS-085 C2 Agility Model Validation Using Case Studies*. In: *Proceedings of the 18th ICCRTS*, Alexandria, VA, June 19-21. DoD CCRP, Washington, DC.
- Fath B.D.**, Dean C.A., and Katzmaier H. (2015). *Navigating the Adaptive Cycle: An Approach to Managing the Resilience of Social Systems*. *Ecology and Society* 20(2) pp. 24-34.
- Ferlie E.**, Fitzgerald L., McGivern G., Dopson S., and Bennett C. (2013). *Making Wicked problems Governable? The Case of Managed Networks in Health Care*. Oxford University Press, Oxford, UK.
- Fernandez S.** and Rainey H.G. (2006). *Managing Successful Organizational Change in the Public Sector*. *Public Administration Review* 66(2) pp. 168-176.
- Ferreira C.M.F.**, Sá Marques T., and Guerra P. (2016). *Bottom-up Initiatives of Economic and Symbolic Innovation in Oporto City Centre*. In: *Innovation for Resilience* pp. 149-165, (Editors: T. de Noronha and H. Pinto), Universidade de Algarve, Portugal.
- Fiksel J.** (2003). *Designing Resilient, Sustainable Systems*. *Environment Science and Technology* 37 pp. 5330-5339.
- Fiksel J.**, Polyviou M., Croxton K. L., and Pettit T.J. (2014). *From Risk to Resilience: Learning to Deal with Disruption*. *MIT Sloan Management Review* 56(2) pp. 79-86.
- Filatotchev I.**, Toms S., and Wright M. (2006). *The Firm's Strategic Dynamics and Corporate Governance Life-cycle*. *International Journal of Managerial Finance* 2(4) pp. 256-279.
- Finkel M.** (2011). *On Flexibility: Recovery from Technological and Doctrinal Surprise on the Battlefield*. Stanford Security Studies, Stanford, CA.
- Firtko J.D.** and Edenborough M. (2007). *Personal Resilience as a Strategy for Surviving and Thriving in the Face of Workplace Adversity: A Literature Review*. *Journal of Advanced Nursing* 60 pp.1-9.
- Flint R.W.** (2010). *Seeking Resilience in the Development of Sustainable Communities*. *Research in Human Ecology* 17(1) pp. 44-57.
- Flora C. B.**, and Flora J. (2008). *Rural Communities: Legacy and Change* (3rd ed.). Westview Press, San Francisco CA.
- Folke C.**, Carpenter S. and Elmqvist T. Gunderson L., Holling C.S., and Walker B. (2002). *Resilience and Sustainable Development: Building Adaptive Capacity in a World of Transformations*. *Ambio* 31(5) pp. 437-440.
- Folke C.**, Carpenter S.R., Walker B., Scheffer M., Chapin T., and Rockstrom J. (2010). *Resilience Thinking: Integrating Resilience, Adaptability and Transformability*. *Ecology and Society* 15(4) pp. 20-29.
- Forsyth P.** (2002). *Low Cost Carriers in Australia: Experiences and Impacts*. Discussion Papers No.17/02 Department of Economics, Monash University, Melbourne, Australia.
- Fracascia L.**, Gianoccaro I., and Albino V. (2018). *Resilience of Complex Systems: State of the Art and Directions for Future Research*. *Complexity* Volume 2018 Article 3421529.
- Francis R.** and Bekera B. (2014). *A Metric and Frameworks for Resilience Analysis of Engineered and Infrastructure Systems*. *Reliability Engineering & System Safety* 121 pp. 90–103.
- Franchin P.** and Cavalieri F. (2015). *Probabilistic Assessment of Civil Infrastructure Resilience to Earthquakes*. *Computer-Aided Civil Infrastructure Engineering* 30 pp. 583–600.
- Fredrickson B.L.** (2001). *The Role of Positive Emotions in Positive Psychology: The Broaden-and-Build Theory of Positive Emotions*. *American Psychologist* 56(3) pp. 218-226.

- Fridgen G., Stepanek C., and Wolf T. (2015).** *Investigation of Exogenous Shocks in Complex Supply Networks – a Modular Petri Net Approach.* International Journal of Production Research 53(5) pp. 1387-1408.
- Freeman S., Hirschhorn L., and Maltz M. (2004).** *The Power of Moral Purpose: Sandler-O’Neill & Partners in the Aftermath of September 11th, 2001.* Organization Development Journal 22(4) pp. 69-81.
- Freese C., Schalk R., and Croon M.A. (2011).** *The Impact of Organizational Changes on Psychological Contracts: A Longitudinal Study.* Personnel Review 40(4) pp. 404-422.
- FSIN (2014).** *A Common Analytical Model for Resilience Measurement: Causal Framework and Methodological Options.* Food Security Information Network, Technical Series No 2. Food and Agriculture Organisation of the United Nations.
- FT (2018).** *Financial Times Lexicon.* Accessed on 13 January 2018 at:
[http://lexicon.ft.com/Term?term=resilience.](http://lexicon.ft.com/Term?term=resilience)
- Funfgeld H. and McEvoy, D. (2012).** *Resilience as a Useful Concept for Climate Change Adaptation?* Planning Theory and Practice 13(2) pp. 324–328.
- Gallopin G. C. (2006).** *Linkages Between Vulnerability, Resilience, and Adaptive Capacity.* Global Environmental Change 16(3) pp. 293-303.
- Gallup (2015).** *State of the American Manager: Analytics and Advice for Leaders.* Report, Gallup.
- Ganin A.A., Massaro E., Gutfrand A., Steen N., Keisler J.M., Kott A., Mangoubi R., and Linkov I. (2016).** *Operational Resilience: Concepts, Design and Analysis.* Scientific Reports 6 Article 19540.
- Gao J., Barzel B., and Barabási A-L. (2016).** *Universal Resilience Patterns in Complex Networks.* Nature 530 pp.307-312.
- GCPSE (2014).** *Foresight as a Strategic Long-Term Planning Tool for Developing Countries.* Global Centre for Public Service Excellence. UNDP, Singapore.
- Geels F.W. (2014).** *Reconceptualising the Co-evolution of Firms-in-industries and their Environments: Developing an Inter-disciplinary Triple Embeddedness Framework.* Research Policy 43(2), pp. 261–277.
- Geha C. (2019).** *Resilience Through Learning and Adaptation: Lebanon’s Power-Sharing System and the Syrian Refugee Crisis.* Middle East Law and Governance 11(1) pp.65-90.
- Ghoshal S. (2005).** *Bad Management Theories are Destroying Good Management Practices.* Academy of Management Learning & Education, 4(1) pp. 75-91.
- Gibson C.A. (2018).** *The Slow Death of BCM or just a Wobbly Knee?* Linked in article, accessed at <https://www.linkedin.com/pulse/slow-death-bcm-just-wobbly-knee-carl-gibson/>.
- Gibson C.A. and Gibson K. (2020).** *The Critical Incident Management Field Guide: Integrating Risk, Preparedness, Crisis and Continuity Management into an Adaptive Approach.* In Press.
- Gibson C.A. and Tarrant M. (2010).** *A Conceptual Models Approach to Resilience.* The Australian Journal of Emergency Management 25 pp. 6-12.
- Giezen M., Salet W., and Bertolini L. (2015).** *Adding Value to the Decision-making Process of Mega Projects: Fostering Strategic Ambiguity, Redundancy, and Resilience.* Transport Policy 44 pp. 169-178.
- Gilbert C., Eyring M., and Foster R.N. (2012).** *Two Routes to Resilience.* Harvard Business Review, December 2012.
- Gitz V. and Maybeck A. (2012).** *Risks, Vulnerabilities and Resilience in the Context of Climate Change.* In: Building Resilience for Adaptation to Climate Change in the Agriculture Sector, Joint Workshop FAO and OECD, 23 -24 April 2012, Rome Italy.
- Golan M.S., Jernegan L.H., and Linkov I. (2020).** *Trends and Applications of Resilience Analytics in Supply Chain Modeling: Systematic Literature Review in the Context of the COVID-19. Pandemic.* Environment Systems and Decisions. Published online 30 May 2020.
- Goodwin V. and Ziegler L. (1998).** *A Test of Relationships in a Model of Organizational Cognitive Complexity.* Journal of Organizational Behaviour 19 pp. 371-386.
- Goranson H.T. (1999).** *The Agile Virtual Enterprise: Cases, Metrics, Tools.* Quorum Books, Westport, CT.
- Gore J., Ward P. Conway G.E., Omerond T.C., Wong B.L.W. Wong., and Stanton N.A. (2018).** *Naturalistic Decision Making: Navigating Uncertainty in Complex Sociotechnical Work.* Cognition, Technology and Work 20 pp.521-527.
- GOS (2017).** *The Futures Toolkit, Edition 1.0.* Government Office for Science, UK Government, November 2017, London, UK.
- Goumagias N., Fernandes K.J., I Cabras I., Li F., Shao J., Devlin S., Hodge V., Cowling P., and Kudenko D. (2016).** *A Conceptual Framework of Business Model Emerging Resilience.* In: 32nd European Group for Organization Studies (EGOS) Colloquium, 07-09 Jul 2016, Italy.
- Grafton E., Gillespie B., and Henderson S. (2010).** *Resilience: The Power Within.* Oncology Nursing Forum 37(6) pp. 698-705.
- Gregory A.J., 2007.** *Target Setting, Lean Systems and Viable Systems: A Systems Perspective on Control and Performance Measurement.* Journal of the Operational Research Society 58(11) pp. 1503-1517.
- Greenfield D., Braithwaite J., Pawsey M., Johnson B., and Robinson M. (2009).** *Distributed Leadership to Mobilise Capacity for Accreditation Research.* Journal of Health Organization and Management 23(2) pp. 255-267.
- Guastello S. J. and Liebovitch M. (2009).** *Introduction to Nonlinear Dynamics and Complexity.* In: Chaos and Complexity in Psychology: The Theory of Nonlinear Dynamical Systems, pp. 1– 40 (Editors: S.I. Guastello, M. Koopmans, and D. Pincus.), Cambridge University Press, New York, NY.
- Gubanov D., Korgin N., Novikov D., and Raikov A. (2014).** *E-expertise: Modern Collective Intelligence.* Springer Nature, Switzerland.
- Gudmundsson A. and Southey G. (2011).** *Leadership and the Rise of the Corporate Psychopath: What can Business Schools Do About the ‘Snakes Inside’?* E-Journal of Social & Behavioural Research in Business, 2(2) pp. 18-27.
- Gustavsson P. (2011).** *Resilience and Procedure Use in the Training of Nuclear Power Plant Operating Crews.* Master’s Thesis in Cognitive Science, Linköping University, Sweden.

- Haase T.W., Ertan G., and Comfort L.K. (2017).** *The Roots of Community Resilience: A Comparative Analysis of Structural Change in Four Gulf Coast Hurricane Response Networks.* Homeland Security Affairs 13 Article 9.
- Haimes Y.Y., Crowther K., and Horowitz, B.M. (2008).** *Homeland Security Preparedness: Balancing Protection with Resilience in Emergent Systems.* Systems Engineering 11 pp. 287-308.
- Hale A.R. and Heijer T. (2006).** *Defining Resilience.* In Resilience Engineering Precepts and Concepts pp. 35-40 (Editors: E. Hollnagel, Woods D.D., and N.G. Leveson). Ashgate, Aldershot, UK.
- Hallegatte S. (2014).** *Economic Resilience: Definition and Measurement.* The World Bank Climate Change Group, Office of the Chief Economist, Washington DC.
- Hamel G. and Välikangas L. (2003).** *The Quest for Resilience.* Harvard Business Review 81(9) pp. 52-63.
- Handmer J. and Dovers S. (2009).** *A Typology of Resilience: Rethinking Institutions for Sustainable Development.* In: The Earthscan Reader on Adaptation to Climate Change pp. 187-210, Earthscan, London, UK.
- Harm B.M. and Craig R.K. (2014).** *The End of Sustainability.* Ensia 8 July, 2014.
- Harries T., McEwen L., and Wragg A. (2018).** *Why it Takes an 'Ontological Shock' to Prompt Increases in Small Firm Resilience: Sensemaking, Emotions and Flood Risk.* International Small Business Journal 36(6) pp. 712-733.
- Havinga J., Dekker S., and Rae A. (2015).** *From Resilience to Routines and Back: Investigating the Evolution of Work Adaptations.* In: Poised to Adapt: Enacting Resilience Through Design, Governance, and Organisation. 7th REA Symposium 26th -29th June 2017.
- Health Foundation (2010).** *Evidence Scan: Complex Adaptive Systems.* The Health Foundation, August 2010.
- Heese M., Kallus W., and Kolodej C. (2013).** *Assessing Behaviour Towards Organizational Resilience in Aviation.* In: 5th REA Symposium Managing Trade-offs, (pp. 67–74), 24–27 June 2013, Soesterberg, Netherlands
- Heifetz R., Grashow A., and Linsky M. (2009a).** *Leadership in a (Permanent) Crisis.* Harvard Business Review 87(7/8) pp. 62-69.
- Heifetz R., Grashow A., and Linsky M. (2009b).** *The Practice of Adaptive Leadership: Tools and Tactics for Changing your Organisation and the World.* Harvard Business Press: Boston, MA.
- Heffernan G. (2017).** *From False Opinions to "False Facts" and Back Again: A Phenomenological Besinnung on Mindfulness and Mindlessness.* The Humanistic Psychologist 45(4) pp. 385-396.
- Hill M. (2013).** *Climate Change and Water Governance: Adaptive Capacity in Chile and Switzerland.* Springer, New York, NY.
- Hillman J. (2013).** *Empirical Research on Organizational Resilience: How Far Have we Come?* In: Autumn Meeting of the Section Sustainability Management of the German Academic Association for Business Research, Dresden.
- Hines S., Luna K., Lofthus J., Marquardt M. and Stelmokas D. (2008).** *Becoming a High Reliability Organization: Operational Advice for Hospital leaders.* AHRQ Publication No. 08-0022, Agency for Healthcare Research and Quality, Rockville, MD.
- Hodge N. (2019).** *Learning from Corporate Collapse.* Risk Management 1 February, 2019.
- Hoffman B.G. (2017).** *Red Teaming: Transform Your Business by Thinking Like the Enemy.* Piatkus Publishing, London, UK.
- Hoffman R.R., and Woods D.D. (2011).** *Beyond Simon's Slice: Five Fundamental Trade-offs that Bound the Performance of Macrocognitive Work Systems.* IEEE Intelligent Systems 26(6) pp. 67-71.
- Holland J.H. (1992).** *Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control, and Artificial Intelligence.* MIT Press, Cambridge, MA.
- Holland J.H. (1999).** *Emergence: From Chaos to Order.* Perseus Books, Reading, MA.
- Holling C.S. (1996).** *Engineering Resilience versus Ecological Resilience.* In Engineering within Ecological Constraints. The National Academy of Sciences, Washington, DC.
- Holling C.S. and Gunderson L.H. (2002).** *Panarchy: Understanding Transformations in Human and Natural Systems.* Island Press, Washington, Covelo, London.
- Hollnagel E. (2002).** *Dependability of Joint Human-computer Systems.* In: Proceedings of the 21st International Conference on Computer Safety, Reliability and Security pp. 4–9, Springer-Verlag, London, UK.
- Hollnagel E., (2009).** *The ETTO Principle: Efficiency-Thoroughness Trade-Off.* Ashgate, Burlington, VT.
- Hollnagel E. (2017).** *Safety II in Practice: Developing the Resilience Potentials.* Routledge, London, UK.
- Hollnagel E., Pariès J., Woods D.D., and Wreathall J. (2011).** *Resilience Engineering in Practice: A Guidebook.* Ashgate, Aldershot, UK.
- Hood C. and Peters G. (2004).** *The Middle Aging of New Public Management: Into the Age of Paradox?* Journal of Public Administration Research and Theory 14(3) pp. 267–282.
- Hong L., and Page S. E. (2004).** *Groups of Diverse Problem Solvers Can Outperform Groups of High-ability Problem Solvers.* Proceedings of the National Academy of Sciences 101(46) pp. 16385-16389.
- Hopkins A. (2002)** *Working Paper 7 - Safety Culture, Mindfulness and Safe Behaviour: Converging Ideas.* National Research Centre for OHS Regulation, Canberra, ACT, Australia.
- Hopkins A. (2009).** *Learning from High Reliability Organisations.* CCH Australia, Melbourne Australia.
- Horne J.F. and Orr J.E. (1998).** *Assessing Behaviors that Create Resilient Organizations.* Employment Relations Today 24(4) pp. 29-39.
- Horton R. (2020).** *Coronavirus is the Greatest Global Science Policy Failure in a Generation.* The Guardian 9 April 2020. Accessed on 1 June 2020 at: <https://www.theguardian.com/commentisfree/2020/apr/09/deadly-virus-britain-failed-prepare-mers-sars-ebola-coronavirus>.
- Houston J., Spialek M.L., Cox J., Greenwood M.M., and First J. (2015).** *The Centrality of Communication and Media in Fostering Community Resilience: A Framework for Assessment and Intervention.* American Behavioral Scientist 59(2) pp. 270-83.

- Huber S.** and **Khun T.** (2017). *Towards an Operationalizable Definition of Resilience*. 7th Resilience Engineering Association Symposium 26th-27th June 2017: Poised to Adapt: Enacting Resilience Potential Through Design, Governance and Organization, Abstract Book Review, University of Liège.
- Huczynski A.A.** and **Buchanan D.A.** (2007). *Organizational Behaviour*. Financial Times Prentice Hall, Harlow, UK.
- Hummel J.R.**, **Lewis L.P.**, **Talaberr L.E.**, and **Schneider J.L.** (2015). *Developing Frameworks to Support Resiliency Assessments*. 2nd National Symposium on Resilient Critical Infrastructure August 18-20, 2015, Philadelphia, PA.
- IAEA** (2015). *The Fukushima Daiichi Accident: Report by the Director General*. International Atomic Energy Agency, Vienna, Austria.
- IFRC** (2014). *IFRC Framework for Community Resilience*. International Federation of Red Cross and Red Crescent Societies. Geneva, Switzerland.
- Jaarin A.A.M.** and **Backhouse C.J.** (2014). *Service Organisations Resilience Through the Application of the Vanguard Method of Systems Thinking: A Case Study Approach*. International Journal of Production Research 52(7) pp. 2026-2041.
- Jackson D.**, **Firtko A.**, and **Edenborough M.** (2007). *Personal Resilience as a Strategy for Surviving and Thriving in the Face of Workplace Adversity: A Literature Review*. Journal of Advanced Nursing 60(1) pp. 1-9.
- Jah A.P.**, **Morrison A.B.**, **Dainer-Best J.**, **Parker S.**, **Rostrup N.**, and **Stanley E.A.** (2015). *Minds at Attention: Mindfulness Training Curbs Attentional Lapses in Military Cohorts*. PLoS ONE 10(2) Article e0116889.
- Jah A.P.**, **ZanESCO A.P.**, **Denkova E.**, **Morrison A.B.**, **Ramos N.**, **Chichester K.**, **Gaddy J.W.**, **Rogers S.L.** (2020). *Bolstering Cognitive Resilience via Train-the-Trainer Delivery of Mindfulness Training in Applied High-Demand Settings*. Mindfulness 11 pp. 683-697.
- Jin M.**, **Ji L.**, and **Peng H.** (2019). *The Relationship Between Cognitive Abilities and the Decision-Making Process: The Moderating Role of Self-Relevance*. Frontiers in Psychology 10 Article 1892.
- Jobidon M-E.**, **Turcotte I.**, **Farrell P.S.E.**, and **Tremblay S.** (2013). *A Framework for the Study of Organisational Agility*. Technical Memorandum, Defence R&D Canada, DRDC, Toronto, Canada.
- Johansson B.** and **Lundberg J.** (2010) *Engineering Safe Aviation Systems: Balancing Resilience and Stability*. In: Handbook of Aviation Human Factors. 2nd edition (Editors: J.A. Wise, D. Hopkin, J. Garland). CRC Press, Boca Raton, FL.
- Johansson B.J.E.** and **Pearce P.** (2014). *Organizational Agility – An Overview*. In: Assessing Command and Control Effectiveness – Dealing with a Changing World (Editors: P. Berggren, S. Nählinder, & E. Svensson) pp. 71-83. Ashgate, Aldershot, UK.
- Johnson N.** (2010). *Social Capital and Organisational Resilience*. Thesis, University of Liverpool, UK.
- Jones C.**, **Chivers S.**, **Rosell T.**, **Chamdal V.**, and **Maltby J.** (2017). *Public Sector Failure and Resilience: Lessons for Healthcare Policy*. Cardiff University and University of Leicester, UK.
- Jones K.H.** (2014). *Engineering Antifragile Systems: A Change in Design Philosophy*. Procedia Computer Science 32 pp.870-875.
- Joseph J.** (2013). *Resilience as Embedded Neoliberalism: A Governmentability Approach*. Resilience, 1(1) pp. 38–52.
- Justice V.**, **Bhaskar P.**, **Pateman H.**, **Cain P.**, and **Cahoon S.** (2016). *US Container Port Resilience in a Complex and Dynamic World*. Maritime Policy and Management 43(2) pp. 179-191
- Kahan J.H.** (2015). *Resilience Redux: Buzzword or Basis for Homeland Security*. Homeland and Security Affairs 11 Article 2.
- Kahneman D.** (2011). *Thinking Fast and Slow*. Penguin, London, UK.
- Kahneman D.** and **Frederick S.** (2005). *A Model of Heuristic Judgment*. In: The Cambridge Handbook of Thinking and Reasoning pp. 267–294 (Editors: K. Holyoak and R. G. Morrison), Cambridge University Press, Cambridge, UK.
- Kaly U.**, **Pratt C.** and **Sale-Mario E.** (2002) *Environmental Vulnerability Index (EVI) Project: Initial Testing of the Global EVI*. Report 453. South Pacific Applied Geoscience Commission. Suva, Fiji.
- Kaplan H. B.** (1999). *Towards an Understanding of Resilience: A Critical Review of Definitions and Models*. In, Resilience and Development pp. 17–83, (Editors: M.D. Glantz and J.L. Johnson). Kluwer Academic, New York, NY.
- Kaplan R.E** and **Kaiser R.B.** (2013). *Fear Your Strengths: What You are Best at Could be Your Biggest Problem*. Berrett -Koehler Publishers Inc., San Francisco, CA.
- Kaplan R.E** and **Kaiser R.B.** (2006). *The Versatile Leader: Make the Most of Your Strengths Without Overdoing it*. John Wiley and Sons, New Jersey, NJ.
- Kaplan R.E.** and **Kasier R.B.** (2003). *Developing Versatile Leadership*. MIT Sloan Management Review 44(4) pp. 19-26.
- Kaplan R.S.** and **Norton D.P.** (2005). *The Office of Strategy Management*. Harvard Business Review 87(4) pp.72-80.
- Kardos M.**, and **Dexter P.** (2017). *A Simple Handbook for Non-Traditional Red Teaming*. Joint and Operational Analysis Division, Defence and Science Technology Group, Department of Defence, Canberra, Australia.
- Kaste K.P.**, **Hoffman R.**, **Caldwell B.**, **Kasdaglis N.**, and **Neville K.J.** (2015). *Introducing Change into Complex Cognitive Systems*. Proceedings of the Human Factors and Ergonomics Society 59th Annual Meeting, 26-30 October 2015, Los Angeles, CA.
- Kay R.** and **Goldspink C.** (2012). *CEO Perspectives on Organisational Resilience*. Research Paper 1, Commonwealth of Australia, Canberra, ACT, Australia.
- Kayes D.C.** (2015). *Organizational Resilience: How Learning Sustains Organizations in Crisis, Disaster, and Breakdowns*. Oxford University Press, New York, NY.
- Kayes D.C.** and **Yoon J.** (2016). *The Breakdown and Rebuilding of Learning During Organizational Crisis, Disaster, and Failure*. Organizational Dynamics 45 pp. 71-79.
- Keating A.**, **Campbell K.**, **Szoenyi M.**, **McQuistan C.**, **Nash D.**, and **Burer M.** (2017). *Development and Testing of a Community Flood Resilience Measurement Tool*. Natural Hazards and Earth System Sciences 17 pp. 77-101.

- Kendra** J.M. and Wachtendorf T. (2003). *Elements of Resilience after the World Trade Center Disaster: Reconstituting New York City's Emergency Operations Centre*. *Disasters* 2003 27(1) pp. 37–53.
- Kennedy** A.A. (2000). *The End of Shareholder Value: The Real Effects of the Shareholder Value Phenomenon and the Crisis It Is Bringing to Business*. Orion Business Books, London UK.
- Kennedy** I. (2001). *Learning from Bristol: The Report of the Public Inquiry into Children's Heart Surgery at the Bristol Royal Infirmary 1984-1995*. UK Parliament, London UK.
- Ker** A. P. (2020). *Risk Management in Canada's Agricultural Sector in Light of COVID-19*. *Canadian Journal of Agricultural Economics* 2020 pp. 1-8.
- Kerr** F. (2014). *Creating and Leading Adaptive Organisations: The Nature and Practice of Emergent Logic*. Thesis, University of Adelaide, Adelaide, Australia.
- Kewell** B.J. (2007). *Language Games and Tragedy: The Bristol Royal Infirmary Disaster Revisited*. *Health, Risk and Society* 8(4) pp. 359-377.
- Kilman** R.H. (2001). *Quantum Organizations*. Davies-Black Publishing, Palo Alto, CA.
- Kimberlin** S., Schwartz S.L., and Austin M.J. (2011). *Growth and Resilience of Pioneering Nonprofit Human Service Organizations: A Cross-case Analysis of Organizational Histories*. *Journal of Evidence Based Social Work* 8(1-2) pp. 4-28.
- Klein** G. (2005). *A Naturalistic Decision Making Perspective on Studying Intuitive Decision Making*. *Journal of Applied Memory and Cognition* 4 pp. 164-168.
- Klein** G. (2017). *Anticipation: How Do We Prepare Ourselves for the Unexpected?* *Psychology Today* 8 Feb 2017.
- Klein** G., Snowden D., and Pin C.L. (2007). *Anticipatory Thinking*. Proceedings of the Eighth International Conference (Editors K. Mosier and U Fischer). Pacific Grove, CA.
- Klein** R.J.T., Nicholls R.J. and Thomalla F. (2004). *Resilience to Natural Hazards: How Useful is This Concept?* EVA Working Paper No. 9, DINAS-COAST Working Paper No.14. Potsdam Institute for Climate Impact Research, Potsdam, Germany.
- Kohlmann** B. (2012). *The Military Needs More Disruptive Thinkers*. *Small Wars Journal*, May 2012.
- Kundzewicz** Z.W. and Kindler J. (1995). *Multiple Criteria for Evaluation of Reliability Aspects of Water Resource Systems*. In: *Modelling and Management of Sustainable Basin-scale Water Systems*. Proceedings of a Boulder Symposium IAHS Publication No. 231.
- Kunreuther** H. and Slovic P. (2020). *Learning from the COVID-19 Pandemic to Address Climate Change*. Accessed on 10 June 2020, at : https://riskcenter.wharton.upenn.edu/wp-content/uploads/2020/06/Learning-from-the-COVID-19-Pandemic-to-Address-Climate-Change_wp.pdf.
- Kuntz** J., Näswall K., and Malinen S. (2014). *Building Resilient Communities Through Resilient Organisations and Employees*. Emergency Management Summer Institute, 10-14 Mar 2014, Wellington, New Zealand.
- Kurasowa** K. (2012). *The Official Report of the Fukushima Nuclear Accident Independent Investigation Commission – Executive Summary*. The National Diet of Japan, Tokyo, Japan.
- Lagadec** P. (1993). *Preventing Chaos in a Crisis: Strategies for Prevention, Control and Damage Limitation*. McGraw-Hill London, UK.
- Lampel** J. Bhalla A., and Jha P.P. (2014). *Does Governance Convey Organisational Resilience? Evidence from UK Employee Owned Businesses*. *European Management Journal* 32(1) pp. 66-72.
- Lamond** J.E. and Proverbs D.G. (2009). *Resilience to Flooding: Lessons from International Comparison*. Proceedings of the Institution of Civil Engineers – Urban Design and Planning 162(2) pp. 63-70.
- Langer** E.J. and Moldoveanu M. (2000). *The Construct of Mindfulness*. *Journal of Social Issues* 56(1) pp. 1-9.
- La Porte** T.R., Roberts K., and Rochlin G.L. (1988). *Aircraft Operations at Sea: The Challenge of High Reliability Performance. Final Report*. Manpower, Personnel and Training Program, Office of Naval Research, Arlington, VA.
- Larrabeiti** D., Romeral R., Soto I., Urueña M., Cinkler T., Szigeti J., and Tapolcai J. (2005). *Multidomain Issues of Resilience*. *Transparent Optical Networks, 2005, Proceedings of 7th International Conference Volume: 1*.
- Lavell** A., Oppenheimer M., Diop C., Hess J., Lempert R., Li J., Muir-Wood R., and Myeong S. (2012). *Climate Change: New Dimensions in Disaster Risk, Exposure, Vulnerability, and Resilience*. In: *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* pp. 25-64 (Editors: C.B. Field, V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J.Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley). A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY,.
- Lawrence** T. B., Suddaby R., and Leca B. (2011). *Institutional Work: Refocusing Institutional Studies of Organization*. *Journal of Management Inquiry* 20 pp. 52-58
- Layne** C. M., Warren J. S., Watson P. J., and Shalev A. Y. (2007). *Risk, Vulnerability, Resistance, and Resilience: Toward an Integrative Conceptualization of Posttraumatic Adaptation*. In *Handbook of PTSD: Science and Practice* pp. 497–520 (Editors: M. Friedman, T. Keane, & P. Resick), Guilford Press, New York, NY.
- Le** Q.B., Seidl R., and Scholz R.W. (2012). *Feedback Loops and Types of Adaptation in the Modelling of Land-use Decisions in an Agent-based Simulation*. *Environmental Modelling and Software* 27-28 pp. 83-96
- Lechner** S., Jacometti J., McBean G., and Mitchison N. (2016). *Resilience in a Complex World – Avoiding Cross-Sector Collapse*. *International Journal of Disaster Risk Reduction* 19 pp. 84-91.
- Lee** E.K.O., Shen C., and Tran T.V. (2009). *Coping with Hurricane Katrina, Psychological Stress and Resilience Among African Americans Evacuees*. *Journal of Black Psychology* 35(1) pp. 5-23.
- Lei** Y, Wang J., Yue Y, Zhou H., and Yin W. (2013). *Rethinking the Relationships of Vulnerability, Resilience, and Adaptation from a Disaster Risk Perspective*. *Natural Hazards* 70, pp. 609-627.

- Leiper N.** (2010). *Why Ansett Airlines Failed and How to Prevent it Happening Again*. *Current Issues in Tourism* 5(2) pp. 134-148.
- Lenchick K.** (2016). *The Economics of Cybersecurity: Boomerang Effects from Misaligned Incentives*. Thesis, Norwegian University of Science and Technology, Oslo, Norway.
- Lengnick-Hall C. A., Beck T. E., and Lengnick-Hall M. L.** (2011). *Developing a Capacity for Organizational Resilience Through Strategic Human Resource Management*. *Human Resource Management Review* 21(3) pp. 243–255.
- Lewis M.W., Andriopoulos C., and Smith W.K.** (2014). *Paradoxical Leadership to Enable Strategic Agility*. *California Management Review* 56(3) pp. 58–77.
- Leveson N.** (2001). *The Role of Software in Recent Aerospace Accidents*. 19th International Safety System Conference. Huntsville, AL.
- Leveson N., Dulac N., and Marais K.** (2009). *Moving Beyond Normal Accidents and High Reliability Organizations: A Systems Approach to Safety in Complex Systems*. *Organization Studies* 30(2-3) pp. 227-249.
- Levey J. and Levey M.** (2019). *Mindful Leadership for Personal and Organisational Resilience*. *Clinical Radiology* 74(10) 739-745.
- Liddy L.** (2005). *The Strategic Corporal: Some Requirements in Training and Education*. *Australian Army Journal* 2(2) pp. 139–147.
- Lindstedt D. and Armor M.** (2017). *Adaptive Continuity: A New Approach*. Rothstein Publishing
- Limnios E.A.M., Mazzarol T., Ghaouani A., and Schilizzi S.G.M.** (2014). *The Resilience Architecture Framework: Four Organizational Archetypes*. *European Management Journal* 32 pp. 104-116.
- Lindoso D.P.** (2017). *Variability and Resilience: Potentials, Convergences and Limitations in Interdisciplinary Research*. *Ambiente and Sociedade*, 20(4) pp. 127-144.
- Linkov L., Bridges T., Creutzig F., Decker J., Fox-Lent C., Kröger W., Lambert J.H., Levermann A., Montreuil B., Nathwani J., Nyer R., Renn O., Scharte B., Scheffler A., Schreurs M., and Thiel-Clemen T.** (2014). *Changing the Resilience Paradigm*. *Nature Climate Change* 4 pp. 407-409.
- Linkov I., Eisenberg D.A., Bates M.E., Chang D., Convertino M., Allen J.H., Flynn S.E., and Seager T.P.** (2013). *Measurable Resilience for Actionable Policy*. *Environmental Science and Technology* 47 pp. 10108-10110.
- Linkov I., Eisenberg D.A., Plourde K., Seager T.P., Allen J., and Kott A.** (2013). *Resilience Metrics for Cyber Systems*. *Environment Systems Decisions* 33(4) pp. 471-476.
- Lissack M.R. and Letiche H.** (2002). *Complexity, Emergence, Resilience, and Coherence: Gaining Perspective on Organizations and their Study*. *Emergence, a Journal of Complexity Issues in Organizations and Management* 4(3) pp. 72-94.
- Liu M., Feng T., Smith P., and Hutchison D.** (2013). *Situational Awareness for Improving Network Resilience Management*. *International Conference on Information Security Practice and Experience* pp. 31-43.
- Lockhart J.C. and Taitoko M.** (2005). *An Examination of Shareholder- Stakeholder Governance Tension: A Case Study of the Collapses of Ansett Holdings and Air New Zealand*. *Advances in Public Interest Accounting* 11 pp. 223-246.
- London First.** (2013). *Reputational Resilience*. Roundtable, 20 November 2013, London, UK.
- Longstaff P.** (2005). *Security, Resilience, and Communication in Unpredictable Environments such as Terrorism, Natural Disasters, and Complex Technology*. Program on Information Resources Policy, Harvard University, Boston, MA.
- Loverde L.** (2005). *Learning Organisations and Quadruple Loops of Feedback. Part 1 Theoretical Models*. *Ingenierias* 8(26) pp. 29-36.
- Lovallo D. and Sibony O.** (2010). *The Case for Behavioural Strategy*. McKinsey Quarterly March 2010.
- Lucy D. and Shepherd C.** (2018). *Organisational Resilience: Developing Change Readiness*. Roffey Park Institute, Horsham, UK.
- Lundberg J. and Johansson B.J.E.** (2015). *Systemic Resilience Model*. *Reliability Engineering and System Safety* 141 pp. 22-32.
- Lundberg J., Rollenhagen C., Hollnagel E., and Rankin A.** (2012). *Strategies for Dealing with Resistance to Recommendations from Accident Investigations*. *Accident Analysis and Prevention* 45 pp. 455-467.
- Luthans F., Youssef C.M., and Avolio B.J.** (2007). *Psychological Capital: Developing the Human Competitive Edge*. Oxford University Press, Oxford, UK.
- McAllister M., and McKinnon J.** (2009). *The Importance of Teaching and Learning Resilience in the Health Disciplines: A Critical Review of the Literature*. *Nurse Education Today* 29 pp. 371-379.
- McCann J.E.** (2004) *Organizational Effectiveness: Changing Concepts for Changing Environments*. *Human Resource Planning Journal* March 2004 issue pp. 42-50.
- McCoy J. and Elwood A.** (2009). *Human Factors in Organisational Resilience – Implications of Breaking the Psychological Contract*. *Business Continuity Journal* 4(1) pp. 5-15.
- McDaniel R.R., Jordan M.E., and Fleeman B.F.** (2003). *Surprise, Surprise, Surprise! A Complexity Science View of the Unexpected*. *Health Care Management Review* 28(3) pp. 266-78.
- MacDonald D.J.** (2000). *The Psychological Contract, Organisational Commitment and Job Satisfaction of Temporary Staff*. *Leadership and Organization Development Journal* 21(2) pp. 84-91.
- McGuinness M. and Johnson N.** (2014). *Exploiting Social Capital and Path-dependent Resources for Organisational Resilience: Preliminary Findings from a Study on Flooding*. *Procedia Economics and Finance* 18 pp. 447– 455.
- McLarnon M.J.W. and Rothstein M.G.** (2013). *Development and Initial Validation of the Workplace Resilience Inventory*. *Journal of Personnel Psychology* 12(2) pp. 63-73.
- McLeod F.** (2017). *Resilience and Resourcefulness: Embracing Change and Opportunity*. Law Council of Australia, Canberra, ACT, Australia.

- MacKinnon** D. and Driscoll Derickson K. (2013). From *Resilience to Resourcefulness: A Critique of Resilience Policy and Activism*. *Progress in Human Geography* 37(2) pp. 253-270.
- Macey** W.H. and Schneider B. (2008). *The Meaning of Employee Engagement*. *Industrial and Organizational Psychology* 1(1) pp. 3-30.
- Mafabi** S., Munene J.C., and Ahiauzu A. (2015). *Creative Climate and Organisational Resilience: The Mediating Role of Innovation*. *International Journal of Organizational Analysis* 23(4) pp. 564-587.
- Maitlis** S. and Christianson M. (2014). *Sensemaking in Organizations: Taking Stock and Moving Forward*. *The Academy of Management Annals* 8(1) pp. 57-125.
- Mankins** M.C. and Steele R. (2005). Turning Great Strategy into Great Performance. *Harvard Business Review* July-August 2005.
- Mansfield-Devine** S. (2018). *The Best Form of Defence – The Benefits of Red Teaming*. *Computer Fraud and Security* 2018(10) pp. 8-12.
- Marais** K., Dulac N., Leveson N. (2004). *Beyond Normal Accidents and High Reliability Organisations: The Need for an Alternative Approach to Safety in Complex Systems*. Engineering Systems Division Symposium, MIT, Cambridge, Mass.
- Marion** R. and Uhl-Bien M. (2007). *Introduction to the Special Issue on Leadership and Complexity*. *The Leadership Quarterly* 18(4) pp. 293–296.
- Margolis** J.D., and Stoltz P. (2010). *How to Bounce Back from Adversity*. *Harvard Business Review*, January-February 2010.
- Masten** A.S. (2001). *Ordinary Magic: Resilience Processes in Development*. *American Psychologist* 56(3) pp. 227-228.
- Matelli** J.A. (2016). *Resiliency Analysis for Cogeneration Plant Design: A Case Study*. Proceedings of ECOS 2016 – The International Conference on Efficiency Cost Optimization, Simulation and Environmental Impact of Energy Systems. June 19-23 2016, Portorož, Slovenia.
- Makin** P., Cooper C., and Cox C. (1996). *Organisations and the Psychological Contract*. Greenwood Publishing, Westport CT, USA.
- Martin** R. and Sunley P. (2007). *Complexity Thinking and Evolutionary Economic Geography*. *Journal of Economic Geography* 7 pp. 573-601.
- Mathieu** C., Babiak P., Jones D. N., Neumann C., and Hare R. D. (2012). *What are the Effects of Psychopathic Traits in a Supervisor on Employees Psychological Distress?* *Journal of Organizational Culture, Communications and Conflict* 16(2) pp. 91-94.
- Meadows** S.O., Miller L.L., and Robson S. (2015). *Airman and Family Resilience: Lessons from the Scientific Literature*. Rand Project Air Force Series on Resilience, Washington, DC.
- Meng** F., Fu G., Farmani R., Sweetapple C., Butler D. (2018). *Topical Attributes of Network Resilience: A Study in Water Distribution Systems*. *Water Research* 143 pp. 376-386.
- Menoni** S. and Schwarze R. (2020). *Recovery During a Crisis: Facing the Challenges of Risk Assessment and Resilience Management of COVID-19*. *Environment Systems and Decisions* <https://doi.org/10.1007/s10669-020-09775-y>.
- Meredith** L.S., Sherbourne C.D., Gaillot S., Hansell L., Ritschard H.V., Parker A.M., and Wrenn G. (2011). *Promoting Psychological Resilience in the US Military*. Rand Center for Military Health Policy Research, Arlington, VA.
- Merritt** D. (2016). *Leveraging Mixed Expertise in Crowdsourcing*. Dissertation, University of Michigan, Ann Arbor, **Miller** F., Osbahr H., Boyd E., Thomalla F., Bharwani S., Ziervogel G., Walker B., Birkmann J., Van der Leeuw S., Rockström J., Hinkel J., Downing T., Folke C., and Nelson D. 2010. Resilience and vulnerability: complementary or conflicting concepts?. *Ecology and Society* 15(3) Article 11.
- Miller** R., Poli R., and Rossel P. (2013). *The Discipline of Anticipation: Exploring Key Issues*. *Global/Local Anticipatory Capacities*, Working Paper 1, United Nations, Educational, Scientific and Cultural Organisation, and the Rockefeller Foundation, New York, NY.
- Mitchel** S.M. (2007). *Resilient Engineered Systems: The Development of an Inherent Systems Property*. PhD Thesis, Texas A&M University, College Station, TX
- Mitchell** T. and Harris K. (2012). *Resilience: A Risk Management Approach*. ODI Background Note, January 2012. Overseas Development Institute, London, UK.
- Moench** M. (2009). *Adapting to Climate Change and the Risks Associated with Other Natural Hazards: Methods for Moving from Concepts to Action*. In: *The Earthscan Reader on Adaptation to Climate Change*, pp. 249-280, Earthscan, London, UK.
- Moldoveanu** M. (2016). *The Construct of Mindfulness Amidst and Along Conceptions of Rationality*. In: *Critical Mindfulness* (Editor: S.M. Fatemi). Springer International Publishing, Cham, Switzerland.
- Moore** M-L., Olsson P., Nilsson W., Rose L., and Westley F. (2018). *Navigating Emergence and System Reflexivity as Key Transformative Capacities: Experiences from a Global Fellowship Program*. *Ecology and Society* 23(2) Article 38.
- Morgan** P.B.C., Fletcher D., and Sarkar M (2015). *Understanding Team Resilience in the World's Best Athletes: A Case Study of a Rugby Union World Cup Winning Team*. *Psychology of Sport and Exercise* 16(1) pp. 91-100.
- Moutsinas** G. and Guo W. (2020). *Node-level Resilience Loss in Dynamic Complex Networks*. *Nature Scientific Reports* 10 Article 3599.
- Mueller** S.C. (2011). *The Influence of Emotion on Cognitive Control: Relevance for Development and Adolescent Psychopathology*. *Frontiers of Psychology* 2 Article 327.
- Nachbagauer** A.G.M. (2019). *On the Influence of Project and Organizational Culture on Managing Turbulences in Projects*. In: *Chapters From the Academic Aspect of Project Management – Research and Teaching Methodologies Volume III*, (Editors: B. Blaskovicks, C. Deák, and Varga A.K.), International network for Professional Education and Research in Process and Project Management.

- Nadin M.** (2015). *Anticipation and Computation. Is Anticipatory Computing Possible?* In: *Anticipation Across Disciplines. Cognitive Science Monographs* 26 pp. 163–257, (Editor: M. Nadin), Springer, Cham, Switzerland.
- Nahapiet J.** and Ghoshal S. (1998). *Social Capital, Intellectual Capital, and the Organizational Advantage*. The Academy of Management Review 23(2) pp. 242-266.
- National Research Council** (2012). *Disaster Resilience: A National Imperative*. National Academies Press, Washington, DC.
- NATO** (2017). *Building Resilience: Collaborative Proposals to Help Nations and Partners*. Allied Command Transformation NATO, Norfolk, VA.
- NATO** (2013). *C2 Agility – Task Group SAS-085 Final Report (STO Technical Report STO-TR-SAS085)*. Brussels, Belgium: NATO Science and Technology Organization.
- Näswall K., Kuntz J., Hodliffe M., and Malinen S.** (2013). *Employee Resilience Scale (EmpRes): Technical Report*. Resilient Organisations Research Report 2013/06.
- Nwachukwu T.** and Robinson M. (2011). *The Role of Diversity in Building Adaptive Resilience*. Arts Council England.
- Nemeth C.P.** (2008). *Resilience Engineering: The Birth of a Notion*. In *Resilience Engineering Perspectives Volume 1: Remaining Sensitive to the Possibility of Failure*, (Editors: E. Hollnagel, C.P. Nemeth and S. Dekker) Ashgate, Aldershot, UK.
- NIAC** (2009). *Critical Infrastructure Resilience Final Report and Recommendations*. National Infrastructure Advisory Council, Washington, DC.
- Nicholls J.** (2012). *An Investigation into the Manifestation of Resilience*. Thesis, Stellenbosch University, South Africa.
- Nilakant V., Walker B., Van Heugten K., Baird R., and De Vries H.** (2014). *Research Note: Conceptualising Adaptive Resilience Using Grounded Theory*. New Zealand Journal of Employee Relations 39(1) pp. 79-86.
- NIST** (2016). *Guide Brief 3 Existing Community Resilience Activities Identifying Solutions to Address Resilience Gaps*. NIST Special Publication 1190GB-3. National Institute of Standards and Technology, US Department of Commerce, Gaithersberg MD.
- NIST** (2017). *2017-2018 Baldrige Excellence Framework: A Systems Approach to Improving Your Organisation's Performance*. National Institute of Standards and Technology, US Department of Commerce, Gaithersberg, MD.
- Nonaka I.** and Nishiguchi T. (2001). *Knowledge Emergence: Social, Technical, and Evolutionary Dimensions of Knowledge Creation*. Oxford University, New York, NY.
- Norris F.** (2010). *Behavioural Science Perspectives on Resilience*. CARRI Research Report 10, Community and Regional Resilience Institute Oak Ridge, TN.
- Norris F., Tracy M., and Galea S.** (2009). *Looking for Resilience: Understanding the Longitudinal Trajectories of Responses to Stress*. Social Science and Medicine 68, pp. 2190–2198.
- Norris F. H., Stevens S. P., Pfefferbaum B., Wyche K. F., and Pfefferbaum R. L.** (2008). *Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness*. American Journal of Community Psychology, 41(1-2) pp. 127-150.
- Nuttall M.** (2010). *Anticipation, Climate Change, and Movement in Greenland*. Les Inuit et le Changement Climatique/The Inuit and Climate Change 34 pp. 21–37.
- O'Connell D., Walker B., Abel N., and Grigg N.** (2015). *The Resilience, Adaptation and Transformation Assessment Framework: From Theory to Application*. Discussion Paper for the Scientific and Technical Advisory Panel of the Global Environment Facility. CSIRO, Canberra, ACT, Australia.
- Oh L-B.** and Teo H-H. (2006). *The Impacts of Information Technology and Managerial Proactiveness in Building Net-enabled Organizational Resilience*. In: *The Transfer and Diffusion of Information Technology for Organizational Resilience*, Vol. 206, pp. 33–50 (Editors: B. Donnellan, T. Larsen, L. Levine and J. DeGross). IFIP, Springer, Boston, MA.
- O'Hare P., White I., and Connelly A.** (2016). *Insurance as Maladaptation: Resilience and the 'Business as Usual' Paradox*. Environment and Planning C: Politics and Space 34(6) pp. 1175-1193.
- Ollerenshaw A., Dahlhaus P., McDonald K., Courvisanos J., Graymore M., Thompson H., Sheil H., Miner A., and Corbett J.** (2014). *Understanding the 2011 Grampians Natural Disaster, Addressing the Risk and Resilience, Final Report*. Center for eCommerce and Communications, Federation University, Ballarat, VIC, Australia.
- Olsson P., Galaz V., and Boonstra W.J.** (2014). *Sustainability Transformations: A Resilience Perspective*. Ecology and Society 19(4) Article 1.
- Ong A.D., Bergeman, C.S. and Boker, S.M.** (2009). *Resilience Comes of Age: Defining Features in Later Adulthood*. Journal of Personality 77(6) pp. 1777-1804.
- O'Rourke T.D.** (2007). *Critical Infrastructure, Interdependencies, and Resilience*. The Bridge, Spring, 2007.
- Orcutt H. K., Erickson D. J., and Wolfe J.** (2004). *The Course of PTSD Symptoms Among Gulf War Veterans: A Growth Mixture Modeling Approach*. Journal of Traumatic Stress 17 pp. 195–202.
- Ortiz-de-Mandojana N.** and Bansal P. (2016). *The Long-term Benefits of Organizational Resilience Through Sustainable Business Practices*. Strategic Management Journal 37: 1615–1631.
- Oshira H., Nomura M., Ichikawa N., Isowa T., Idaka., Sato A., Fukuyama S., Nakajima T., Yamada J.** (2006). *Association of Neural and Physiological Responses During Voluntary Emotion Suppression*. NeuroImage 29(3) pp. 721-733.
- Ostrom E.** (2010). *Beyond Markets and States: Polycentric Governance of Complex Economic Systems*. American Economic Review 100 pp. 1-33.
- Oxfam** (2013). *A Multidimensional Approach for Measuring Resilience*. Oxfam GB Working Paper.
- Pal N., and Pantaleo D.C.** (2005). *The Agile Enterprise: Reinventing your Organization for Success in an On-demand World*. Springer, New York, NY.
- Palin P.** (2013). *Supply Chain Resilience: Diversity + Self-organization = Adaptation*. Homeland Security Affairs 9 Article 14.

- Panteli M.** and Mancarella P. (2011). *Modelling and Evaluating the Resilience of Critical Electrical Power Infrastructure to Extreme Weather Events*. IEEE Systems Journal 11(3) pp. 1733-1742.
- Panteli M.**, and Mancarella P. (2015). *Influence of Extreme Weather and Climate Change on the Resilience of Power Systems: Impacts and Possible Mitigation Strategies*. Electric Power Systems Research 127 pp. 259–270.
- Parasat M.M.**, Sabahi S., and Kamalahmadi M. I. (2018). The Relationship Between Firm Resilience to Supply Chain Disruption and Firm Innovation. In: *Revisiting Supply Chain Risk* (Editors: G. Zsidisian and M. Henke), Springer Series in Supply Chain Management, Volume 7, Springer, Cham, Switzerland .
- Paries J.** (2006). *Complexity, Emergence, Resilience*. In *Resilience Engineering: Concepts and Precepts*, pp. 43-53. (Editors: E. Hollnagel, D. D. Woods, N. Leveson). Ashgate Press, Aldershot, UK.
- Park J.**, Seager T.P., and Rao P.S.C., (2011). *Lessons in Risk Versus Resilience-based Design and Management*. Integrated Environmental Assessment and Management 7(3) pp. 396-399.
- Park J.**, Seager T.P., Rao P.S.C., Convertino M., and Linkov I. (2013). *Integrating Risk and Resilience Approaches to Catastrophe Management in Engineering Systems*. Risk Analysis, 33 (3) pp. 356–367.
- Pasieczny J.** (2017). *Organisational Pathologies Under Conditions of Economic Downturn*. Economics and Culture 14(1) pp. 21-30.
- Patel S.S.**, Rogers, M.B., Amlôt R., and Rubin G.J. (2017). *What Do We Mean by 'Community Resilience'? A Systematic Literature Review of How It Is Defined in the Literature*. Plos Currents Disasters Feb 1 Edition 1.
- Paton D.** (2015). *Risk, Resilience, and Readiness: Developing an All-Hazards Perspective*. In: Hazards, Risks and Society, pp. 307-322 (Editors: A. Collins, S. Jones, B. Manyena, S. Walsh and J.F. Shroder), Elsevier, London, UK.
- Paton D.**, Smith L., and Violanti J. (2000). *Disaster Response: Risk Vulnerability and Resilience*. Disaster Prevention and Management 9(3) pp. 173-180.
- Patriarca R.**, Bergström J., Gravio D. and Costantino F. (2018). *Resilience Engineering: Current Status of the Research and Future Challenges*. Safety Science 102 pp. 79-100.
- Patterson M.D.** and Wears R.L. (2015). *Resilience and Precarious Success*. Reliability Engineering and System Safety 141 pp. 45-53. PLoS Currents 9.
- Paul S.A.** (2010). *Understanding Together: Sensemaking in Collaborative Information Seeking*. Dissertation, Pennsylvania State University, Pittsburgh, PA.
- Pegram T.** (2020). *Coronavirus is a Failure of Global Governance – Now the World Needs a Radical Transformation*. The Conversation 5 may 2020. Accessed on 4 June 2020 at: <https://theconversation.com/coronavirus-is-a-failure-of-global-governance-now-the-world-needs-a-radical-transformation-136535>.
- Pellissier R.** (2011). *The Implementation of Resilience Engineering to Enhance Organizational Innovation in a Complex Environment*. International Journal of Business and Management 6(1) pp. 145-164.
- Pelser H.J.**, Bosch A., and Schurink W. (2013). *An Organisational Coherence Model to Maintain Employee Contributions During Organisational Crises*. SA Journal of Human Resource Management 14(1) pp. 1-8.
- Pendall R.**, Foster K.A., and Cowell M. (2010) *Resilience and Regions: Building Understanding of the Metaphor*. Cambridge Journal of Regions, Economy and Society 3(1) pp. 71–84.
- Pennycook G.**, Cheyne J.A., Barr N., Koehler D.J., and Fugelsang J.A. (2015). *On the Reception and Detection of Pseudo-profound Bullshit*. Judgement and Decision Making 10(6) pp. 549-563.
- Pérez Ríos, J.**, 2010. *Models of Organizational Cybernetics for Diagnosis and Design*. Kybernetes 39(9/10) pp. 1529–1550.
- Perrow C.** (1984.) *Normal Accidents: Living with High-risk Technologies*. Basic Books Inc. New York, NY.
- Pfefferbaum B.**, Pfefferbaum R.L., and Van Horn R.L. (2015). *Community Resilience Interventions: Participatory, Assessment-based, Action-oriented Processes*. American Behavioral Scientist 59(2) pp. 238-53.
- Pich M.T.**, Loch C.H., and De Meyer A. (2002). *On Uncertainty, Ambiguity, and Complexity in Project Management*. Management Science 48(8) pp. 1008–1023.
- Pim** (2019). *Mass Incompetency in Business: The Way We Promote People is Dead Wrong*. Corporate Rebels, accessed at: <https://corporate-rebels.com/peter-principle/>.
- Pinto J.K.** and Slevin D.P. (1988). *Critical Success Factors Across the Project Life Cycle: Definitions and Measurement Techniques*. Project Management Journal 19(3) pp. 67–75.
- Pipe T.B.**, Buchda V.L., Launder S., Hudak B., Hulvey L., Karns K.E., and Pendergast D. (2012). *Building Personal and Professional Resources of Resilience and Agility in the Healthcare Workplace*. Stress & Health 28(1) pp. 11-22.
- Plodinec M.J.** (2013). *Definition of Community Resilience: An Analysis*. CARRI Report pp. 1–14. Oak Ridge National Laboratory, Oak Ridge, TN.
- Plodinec M.J.**, Edwards W.C., and White R.K. (2014). *Applications of a “Whole Community” Framework for Enhancing Community or Campus Resilience*. Procedia Economics and Finance 18 pp. 9 – 16.
- Plough A.**, Fielding J.E., Chandra A., Williams M., Eisenman D., Wells K.B., Law G.Y., Fogleman S., and Magaña A. (2013). *Building Community Disaster Resilience: Perspectives from a Large Urban County Department of Public Health*. American Journal of Public Health 103(7) pp. 1190-1197.
- Poli R.** (2009). *The Many Aspects of Anticipation*. Foresight 12(3) pp. 7-17.
- Poli R.** (2014). *Anticipation: A New Thread for the Social Sciences?*. Cadmus 2(3) pp. 23-36.
- Pollock K.** (2016). *Resilient Organisation or Mock Bureaucracy: Is Your Organisation “Crisis-prepared or Crisis-prone”?* Emergency Planning College Occasional Paper Number 16 March 2016.
- Pope R.** (2017). *The NHS: Sticking Fingers in Ears, Humming Loudly*. Journal of Business Ethics 145 pp. 577-598.

- Pope R.** and Burnes B. (2013). *A Model of Organisational Dysfunction with the NHS*. Journal of Health Organization and Management 27(6) pp. 676-697.
- Pourhejazy P.**, Kwon O.K., Chang Y.-T., and Park H. (2017). *Evaluating Resiliency of Supply Chain Network: A Data Envelopment Analysis Approach*. Sustainability 9 Article 255.
- Prahad R.K.** and Bhattacharya P. (2018). *Building Organisational Resilience: The Role of Cherishing at Work*. International Journal of Entrepreneurship and Innovation Management 22(3) pp. 269-285.
- Prezenski S.**, Brechmann A., Wolf S., and Russwinkel N. (2017). *A Cognitive Modeling Approach to Strategy Formation in Dynamic Decision Making*. Frontiers in Psychology 8 Article 1335.
- Proag V.** (2014a). *Assessing and Measuring Resilience*. Procedia Economics 18 pp. 222-229.
- Proag V.** (2014b). *The Concept of Vulnerability and Resilience*. Procedia Economics 18 pp. 369-376.
- Rahimi M.** and Madni A.M. (2014). *Toward A Resilience Framework for Sustainable Engineered Systems*. Procedia Computer Science 28 pp. 809-817.
- Rajamäki J.**, Rathod P., Ahlgren A., Aho J., Takari M., and Ahlgren S. (2012). *Resilience of Cyber-physical System a Case Study of Safe School Environment*. 2012 European Intelligence and Security Informatics Conference.
- Raman S.** and French T. (2017). *Designing a culture of resilience: Embedding innovation in health and social care integration in Scotland*. In: NHS Highland Research, Development & Innovation Annual Conference 2017: Resilience for Public Health, for the NHS, for Communities, for Patients and for All, 24 November 2017, Centre for Health Science, Inverness.
- Rand** (2015). *Community Resilience Learn and Tell Toolkit*. Rand Corporation, Washington DC.
- Rand** (2018). *Community Resilience*. Rand Corporation, accessed on 13 January 2018 at: www.rand.org/topics/community-resilience.html.
- Reason J.T.** (2000). *Safety Paradoxes and Safety Culture*. Injury Control and Safety Promotion 7(1) pp.3-14.
- Reason J.** (2001). *The Dimensions of Organisational Resilience to Operational Hazards*. British Airways Human Factors Conference Enhancing Operational Integrity, 24 May, 2001.
- Reich J.W.**, Zautra A.J., and Hall J.S. (Editors) (2010). *Handbook of Adult Resilience*. Guildford Press, New York, NY.
- Reinmoeller P.** and van Baardwijk N., (2005). *The Link Between Diversity and Resilience*. MIT Sloan Management Review 46(4) pp. 61-65.
- Reggiani A.**, de Fraff T., and Nijkamp P. (2001). *Resilience: An Evolutionary Approach to Spatial Economic Systems*. Tinbergen Institute Discussion Paper, Amsterdam, Netherlands.
- Renschler C.S.**, Frazier A.E., Arendt L.A., Cimellaro G-P., Reinhorn A.M., and Bruneau M. (2010) *A Framework for Defining and Measuring Resilience at the Community Scale: The PEOPLES Resilience Framework*. Technical Report MCEER-10-0006. National Institute for Standards and Technology (NIST), Building and Fire Research Laboratory. Buffalo, NY.
- Rerup C.** (2001). *'Houston We Have a Problem': Anticipation and Improvisation as Sources of Organizational Resilience*. Compartimento Organizacional E Gestão 7(1) pp. 27-44.
- ReSIST** (2007). *Resilience-Building to Resilience-Scaling Technologies: Directions*. Deliverable D13, ReSIST (Resilience for Survivability in IST) European Network of Excellence.
- Resnick J.** (2011). *Materialization of Speculation into Foresight and Design*. Thesis, OCAD University, Toronto, Ontario, Canada.
- Richardson A.** (2016). *Dismantling the Wall: the Simplification of Complex Socio-Technological Systems and the Implications for Urban Resilience*. Thesis, RMIT University, Melbourne, Australia.
- Richardson G.E.** (2002). *The Meta-theory of Resilience and Resiliency*. Journal of Clinical Psychology 58(3) pp. 307-321.
- Richardson T.** (2020). *'They Failed at Risk Management': Fundie Who Picked the Crash*. Financial Review 25 May 2020. Access 8 June 2020 at: <https://www.afr.com/markets/equity-markets/spenceley-warns-equity-investors-of-extended-pandemic-nightmare-20200324-p54db7>.
- Riegler A.** (2001). *The Role of Anticipation in Cognition*. In: Computing Anticipatory Systems, Proceedings of the American Institute of Physics (Editor: D.M. Dubois).
- Roe E.**, and Schulman P.R. (2008). *High Reliability Management: Operating on the Edge*. Stanford Business Books, Stanford, CA.
- Roberts K. H.** and Bea R. (2001). *Must Accidents Happen? Lessons from High-reliability Organizations*. Academy of Management Executive 15(3) pp. 70-78.
- Robertson I.T.**, Cooper C.L., Sarkar M., and Curran T. (2015). *Resilience Training in the Workplace from 2003 to 2004: A Systematic Review*. Journal of Occupational and Organizational Psychology 88(3) pp. 533-562.
- Robson S.** and Salcedo N. (2014). *Behavioural Fitness and Resilience: A Review of Relevant Constructs, Measures, and Links to Well-being*. Rand Project Air Force Series on Resilience, Washington DC.
- Roelants B.**, Dovgan D., Eum H., and Terrasi E. (2012). *The Resilience of Cooperative Model*. CECOP-CICOPA, Brussels Belgium.
- Rogers P.** (2011). *Development of Resilient Australia: Enhancing the PPRR Approach with Anticipation, Assessment and Registration of Risks*. Australian Journal of Emergency Management 26(1) pp. 54-58.
- Rose A.** (2004). *Defining and Measuring Economic Resilience to Earthquakes*. In *Research Progress and Accomplishments 2003-2004*. The Multidisciplinary Center for Earthquake Engineering Research, Buffalo, NY.
- Rose A.** (2007). *Economic Resilience to Natural and Man-made Disasters: Multidisciplinary Origins and Contextual Dimensions*. Environmental Hazards 7 (4) pp. 383– 395.
- Rose A.** and Krausmann, E. (2013). *An Economic Framework for the Development of a Resilience Index for Business Recovery*. International Journal of Disaster Risk Reduction 5 pp. 73–83.

- Rosness R.**, Haavik T., and Evjemo T.O. (2015). *Supporting Prospective Sensemaking in an Unpredictable World*. in Proceedings of the 6th Resilience Engineering Association Symposium, Lisbon, Portugal, 22–25 June, pp.57–62.
- Rice J.B.** and Caniato F. (2003) *Building a Secure and Resilient Supply Network*. Supply Chain Management Review 7(5) pp. 22-30.
- Ruiz-Martin C.**, Rios J.M.P., Wainer G., Pajares J., Hernández C., and Lopez-Paredes A. (2017). *The Application of the Viable System Model to Enhance Organizational Resilience*. In: Advances in Management Engineering (Editor: C. Hernández), Chapter 5. Springer International Publishing AG, Cham, Switzerland.
- Rupprecht S.**, Koole W., Chasklason M., Tamdjidi C. and West M. (2019). *Running Too Far Ahead? Towards a Broader Understanding of Mindfulness in Organisations*. Current Opinion in Psychology. 28 pp. 32-36.
- Ryan L.** (2016). *Ten Reasons Out-of-the-Box Thinkers are Unhappy Employees*. Forbes 27 June, 2016.
- Salisu I.** and Hashim N. (2016). *A Critical Review of Scales Used in Resilience Research*. Journal of Business and Management 19(4) pp. 23-33.
- Sanchis R.** and Poler, R. (2013). *Definition of a Framework to Support Strategic Decisions to Improve Enterprise Resilience*. In IFAC Proceedings 46(9) pp. 700–705.
- Sapountzaki K.** (2007). *Social Resilience to Environmental Risks: A Mechanism of Vulnerability Transfer?* Management of Environmental Quality: An International Journal 18(3) pp. 274-297.
- Sarkar M.** and Fletcher D. (2014). *Ordinary Magic, Extraordinary Performance: Psychological Resilience and Thriving in High Achievers*. Sport, Exercise and Performance Psychology 3 (1) pp. 46-60.
- Schad J.**, Lewis M.W., Raisch S., and Smith W.K. (2017). *Paradox Research in Management Science: Looking Back to Move Forward*. Academy of Management Annals 10(1) pp. 5-64.
- Sharma P.**, Leung T.Y., Kingshott R.P.J., Davcik N.S., and Cardinali S. (2020). *Managing Uncertainty During a Global Pandemic: An International Business Perspective*. Journal of Business Research 116 pp. 188-192.
- Schein E.H.** (1985). *Organisational Culture and Leadership*. Jossey-Bass Publishing, San Francisco, CA.
- Scheffer M.** (2009). *Critical Transitions in Nature and Society*. Princeton University Press, Princeton, NJ.
- Schmid R.S.** and Pawlowsky P. (2018). *Emergency Management in Extreme Situations – Towards a Multiteam Learning Process Model*. Integrated Economy and Society: Management, Diversity, Creativity, Knowledge and Learning, and Technology International Conference 16-18 May 2018, Naples, Italy.
- Schmidt B.**, Loerbroks A., Herr R., Litaker D., Wilson M., Kastner M., and Fischer J. (2014). *Psychosocial Resources and the Relationship Between Transformational Leadership and Employees' Psychological Strain*. Work: A Journal of Prevention, Assessment & Rehabilitation 49(2) pp.315-24.
- Scholten K.**, Sharkey Scott P., and Fynes B. (2014). *Mitigation Processes – Antecedents for Building Supply Chain Resilience*. Supply Chain Management: An International Journal 19(2) pp. 211-228.
- Schultz F.**, Kleinnijenhuis J., Oegema D., Utz S., and van Atteveldt W. (2012). *Strategic Framing in the BP Crisis: A Semantic Network Analysis of Associative Frames*. Public Relations Review 38 pp. 97-107.
- Schwabinger M.** and Pérez Ríos, J. (2008). *System Dynamics and Cybernetics: A Synergetic Pair*. System Dynamics Review 24(2) pp. 145–174.
- Seery M.D.**, Holman E.A., and Cohen Silver R. (2010). *Whatever Does No Kill Us: Cumulative Lifetime Resilience, Vulnerability, and Resilience*. Journal of Personality and Social Psychology 99(6) pp. 1025.
- Seidl R.** (2014). *The Shape of Ecosystem Management to Come: Anticipating Risks and Fostering Resilience*. BioScience 64(12) pp. 1159-1169.
- Seijts G.**, Bilou N., and Crossan M. (2010). *Coping With Complexity*. Ivey Business Journal. May/June 2010.
- Seligman M.E.P.**, Railton P., Baumeister R. F., and Sripada C. (2013). *Navigating into the Future or Driven by the Past*. Perspectives on Psychological Science 8(2), pp. 119-141.
- Sharma N.** (2007). *Sensemaking: Bringing Theories and Tools Together*. Proceedings of the American Society for Information and Technology 43(1) pp. 1-8.
- Shaw G.L.** and Harrald J.R. (2004). *Identification of the Core Competencies of Executive Level Business Crisis and Continuity Managers*. Journal of Homeland Security and Emergency Management 1(1) pp. 1-14.
- Shaw K.** (2012). *The Rise of the Resilient Local Authority?* Local Government Studies 38(3) pp. 281-300.
- Shaw K.** and Maythorne L. (2013). *Managing for Local Resilience: Towards a Strategic Approach*. Public Policy and Administration 28(1) pp. 43-65.
- Sheffi Y.** (2005). *The Resilient Enterprise – Overcoming Vulnerability for Competitive Advantage*. MIT Press, Cambridge, MA.
- Shih R.A.**, Meadows S.O., Mendelof J., and Bowling K. (2015). *Environmental Fitness and Resilience: A Review of Relevant Constructs, Measures, and Links to Well-being*. Rand Project Air Force Series on Resilience, Washington DC.
- Shin J.**, Taylor M. S., and Seo M. (2012). *Resources for Change: The Relationships of Organizational Inducements and Psychological Resilience to Employees' Attitudes and Behaviors Toward Organizational Change*. Academy of Management Journal 55(3) pp. 727-748.
- Shinozuka M.**, Chang S.E., Cheng T-C., Feng M., O'Rourke T.D., Saadeghvaziri M.A., Dong X., Wang Y., and Shi P. (2004). *Resilience of Integrated Power and Water Systems*. In: Research Progress and Accomplishments 2003-2004, pp. 65-86. Multidisciplinary Center for Earthquake Engineering Research University at Buffalo, State University of New York.
- Siegel A.W.** and Schraagen J.M. (2017). *Team Reflection Makes Resilience-related Knowledge Explicit Through Collaborative Sensemaking: Observation Study at a Rail Post*. Cognition, Technology and Work 19 pp. 127-142.
- Simard M.** and Laberge D. (2016). *Absurd Decisions in and around Projects: A Case Study*. 21st Conference, International Academy of Management and Business, 18-20 May 2016, Montreal, Canada.

- Simonton D.K.** (2000). *Creativity*. *American Psychologist* 55 pp.151–158.
- Sjoberg M.**, Wallenius C., and Larsson G. (2011). *Leadership in Complex, Stressful Rescue Operations*. *Disaster Prevention and Management* 20(2) pp. 199-212.
- SmartResilience** (2016). *Smart Resilience Indicators for Smart Critical Infrastructures*. IVL Report No. E 002, SmartResilience Consortium. September 2016, Stuttgart, Germany.
- Smith M.** (2014). *Multi-sector Collaboration for Resilience*. In *Turbulence: A Corporate Perspective on Collaborating for Resilience* pp. 68-78 (Editor: R. Kupers), Amsterdam University Press, Amsterdam, NL.
- Smith P. J.**, Spencer A. L., and Billings C. (2009). *Layered Resilience*. In: C. P. Resilience Perspectives, volume 2: Preparation and Restoration, pp. 149-164 (Editors: C.P. Nemeth, E. Hollnagel, and S. Dekker). Ashgate, Farnham, UK.
- SMR** (2016). *Smart Mature Resilience D1.2 Survey Report on EU-Sectoral Approaches*. Centre for Integrated Emergency Management (CIEM). University of Agder, Kristiansand, Norway.
- Somers S.** (2009). *Measuring Resilience Potential: An Adaptive Strategy for Organizational Crisis Planning*. *Journal of Contingencies and Crisis Management*, 17(1) pp. 12-23.
- Sommers S.A.**, Howell J.M., and Hadley C.N. (2016). *Keeping Positive and Building Strength: The Role of Affect and Team Leadership in Developing Resilience During an Organizational Crisis*. *Group & Organisation Management* 41(2) pp. 172-202.
- Soulier E.** and Caussanel J. (2002). *Narrative Tools to Improve Collaborative Sense-making*. AAI Technical Report WS-02-09, Association for the Advancement of Artificial Intelligence.
- Spaans M.**, Spoelstra M., Douze E., Pieneman R., and Grisogono A. (2009). *Learning to be Adaptive*. In Proceedings of the 14th ICCRTS, June 15-17, 2009. Command and Control Research Program, Department of Defense, Washington, DC.
- Spangler N.**, Koesten J., Fox M., and Radel J. (2012). *Employer Perceptions of Stress and Resilience Intervention*. *Journal of Occupational & Environmental Medicine* 54(11) pp. 1421-1429.
- Sparr J.L.** (2018). *Paradoxes in Organizational Change: The Crucial Role of Leaders' Sensegiving*. *Journal of Change Management* 18 pp. 162-180.
- Stanovich K.E.** (2011). *Rationality and the Reflective Mind*. Oxford University Press, Oxford, UK.
- Stanovich K.E.** and West R.F. (2000). *Individual Differences in Reasoning: Implications for the Rationality Debate?* *Behavioral and Brain Sciences* 23 pp. 645–726.
- Stanovich K. E.** and West R. F. (2003). *Evolutionary Versus Instrumental Goals: How Evolutionary Psychology Misconceives Human Rationality*. In: *Evolution and the Psychology of Thinking: The Debate* pp. 171–230 (Editor: D. E. Over), Psychology Press, Hove, UK.
- Stares P.B.** and Wit J.S. (2009). *Preparing for Sudden Change in North Korea*. Center for Preventive Action. Council on Foreign Relations, New York, NY.
- Stephenson A.** (2010). *Benchmarking the Resilience of Organisations*. Thesis, University of Canterbury, NZ.
- Sterman J.D.** (2001). *System Dynamics Modelling: Tools for Learning in a Complex World*. *California Management Review*. 43(4) pp. 8-25.
- Stern E.** (2013). *Preparing: The Sixth Task of Crisis Leadership*. *Journal of Leadership Studies* 7(3) pp. 51-56.
- Stewart J.**, and O'Donnell M., (2007). *Implementing Change in a Public Agency: Leadership, Learning and Organisational Resilience*. *International Journal of Public Sector Management* 20(3) pp. 239-251.
- Strigini L.** (2012). *Fault Tolerance and Resilience: Meanings, Measures and Assessment*. In: *Resilience Assessment and Evaluation of Computing Systems* pp. 3-24 (Editors: K. Wolter, A. Avritzer, M. Vieira, A. van Moorsel). Springer, New York, NY.
- Storbeck J.** and Clore G.L. (2007). *On the Interdependency of Cognition and Emotion*. *Cognitive Emotion* 21(6) pp. 1212-1237.
- Stumpff E-M.** (2013). *New in Town? On Resilience and 'Resilient Cities'*. *Cities* 32 pp. 164–166.
- Surana A.**, Kumara S., Greaves M., and Raghavan U. (2005). *Supply-chain Networks: A Complex Adaptive Systems Perspective*. *International Journal of Production Research* 43(20) pp. 4235–4265.
- Tadić D.**, Aleksić A., Stefanović M., and Arsovski S. (2014). *Evaluation and Ranking of Organizational Resilience Factors by Using a Two-Step Fuzzy AHP and Fuzzy TOPSIS*. *Mathematical Problems in Engineering*, 2014, pp. 1–13.
- Taleb N.N.** (2008). *The Black Swan: The Impact of the Highly Improbable*. Penguin Press, London, UK.
- Taleb N.N.** (2012). *Antifragile: Things that Gain from Disorder*. Random House, New York, NY.
- Tang J.**, Lau G., and Abbass H.A. (2020). *Simulation and Computational Red Teaming for Problem Solving*. John Wiley and Sons, Hoboken NJ.
- Tang Y-Y.** (2017). *The Neuroscience of Mindfulness Meditation*. Palgrave Macmillan, Cham, Switzerland.
- Templer K.J.** (2018). *Why Do Toxic People Get Promoted? For the Same Reason Humble People Do: Political Skill*. *Harvard Business Review* 10 July 2018.
- Termeer C.J.A.M.**, Dewulf A., and Biesbroek R. (2019). *A Critical Assessment of the Wicked Problem Concept: Relevance and Usefulness for Policy Science and Practice*. *Policy and Society* 38(2) pp. 167-179
- Tierney K.** (2003). *Conceptualizing and Measuring Organizational and Community Resilience: Lessons from the Emergency Response Following the September 11, 2001 Attack on the World Trade Center*. Preliminary Paper 329, University of Delaware Disaster Research Center, Newark, DE.
- Tierney K.J.** (1997). *Business Impacts of the Northridge Earth-quake*. *Journal of Contingencies and Crisis Management* 5 pp. 87–97.
- Tolk J.N.**, Cantu J., and Beruvides M. (2015). *High Reliability Organization Research: A Literature Review for Health Care*. *Engineering Management Journal* 27(4) pp. 218-237.

- Tracey N.** and French E. (2017). *Influence Your Firm's Resilience Through Its Reputation: Results Won't Happen Overnight but they Will Happen!* Corporate Reputation Review 20(1) pp. 57-75.
- Trexler M.** (2020). *COVID-19 Has Exposed the Weakness of Traditional Risk Management Strategies*. Brink News 26 April, 2020. Accessed 10 June, 2020 at: <https://www.brinknews.com/covid-19-exposes-the-weakness-of-business-global-risk-management-strategies-coronavirus-economic-impact-companies/>.
- Tschakert P.**, and Dietrich K.A. (2010). *Anticipatory Learning for Climate Change Adaptation and Resilience*. Ecology and Society 15, Article 11.
- Tucker A.L.**, Heisler W.S., and Janisse L.D. (2013). *Organizational Factors that Contribute to Operational Failures in Hospitals*. Working Paper 14-023, September 4, 2013. Harvard Business School, Boston, MA.
- Tugade M.M.** and Fredrickson B.L. (2004). *Resilient Individuals Use Positive Emotions to Bounce Back from Negative Emotional Experiences*. Journal of Personality and Social Psychology 86(2) pp. 320-333.
- Turoff M.** (2015). *The Paradox of Emergency Management*. In: Proceedings of the ISCRAM 2015 Conference, Kristiansand, May 24-27, 2015 (Editors: Palen, Buscher, Comes and Huges).
- UK Government** (2012). *Blackett Review of High Impact Low Probability Risks*. Government Office for Science, London UK.
- UN-ISDR** (2009). *Terminology on Disaster Risk Reduction*. United Nations International Strategy for Disaster Risk Reduction, Geneva, Switzerland.
- Uscher-Pines L.**, Chandra A., and Acosta J. (2013). *The Promise and Pitfalls of Community Resilience*. Disaster Medicine & Public Health Preparedness 7(6) pp. 603-6.
- USAID** (2015). *Resilience at USAID*. Accessed on 1 January 2018, at: http://pdf.usaid.gov/pdf_docs/PBAAE178.pdf.
- US National Park Service** (2017). *Modularity in Resilient Systems*. Accessed on 13 March, 2018 at: https://www.nps.gov/subjects/culturallandscapes/resilientsystems_modularity.htm
- Vale L.J.** and Campanella T.J. (2005). *The Resilient City: How Modern Cities Recover from Disaster*. Oxford University Press, New York, NY.
- Valikangas L.** (2010). *The Resilient Organisation: How Adaptive Cultures Thrive Even When Strategy Fails*. McGraw Hill Professional, New York, NY.
- Vanderbilt-Adriance E.** and Shaw D.S. (2008). *Conceptualizing and Re-Evaluating Resilience Across Levels of Risk, Time, and Domains of Competence*. Clinical Child and Family Psychology Review 11(1-2) pp. 30-58.
- Van der Vegt G.**, Essens P. Wahlstrom M., and George G. (2015) *Managing Risk Resilience: From the Editors*. Academy of Management Journal 58(4) pp. 971-980.
- Vanhove A.J.**, Herian M., Perez A.L.U., Harris P.D., and Lester P.B. (2015). *Can Resilience be Developed at Work? A Meta-analytic Review of Resilience-building Programme Effectiveness*. Journal of Occupational and Organizational Psychology 88(2) pp. 278-307.
- Van Wart M.** and Kapucu N. (2011). *Crisis Management Competencies: The Case of Emergency Managers in the USA*. Public Management Review 13(4) pp. 489-511.
- Vaughn D.** (2016). *The Challenger Launch Decision: Risk Technology, Culture, and Deviance at NASA*. Enlarged Edition. The University of Chicago Press. London, UK.
- Velásquez T.** (2010). *Chaos Theory and the Science of Fractals in Finance*. ODEON 5 pp. 229-264.
- Verhulsta E.** (2014). *Applying Systems and Safety Engineering Principles for Antifragility*. Procedia Computer Sciences 4(32) pp. 842– 849.
- Vogus T.J.** and Sutcliffe K.M. (2007). *Organizational Resilience: Towards a Theory and Research Agenda*. IEEE Systems, Man, and Cybernetics 2007 Proceedings 2007 pp. 3418–3422.
- Vogus T.J.** and Sutcliffe K.M. (2012). *Organisational Mindfulness and Mindful Organizing: A Reconciliation and Path Forward*. Academy of Management Learning and Education 11(4) pp. 722-735.
- Vos M.**, van der Molen I., and Mykkänen M. (2017). *Communication in Turbulent Times: Exploring Issue Arenas and Crisis Communication to Enhance Organisational Resilience*. Jyväskylä University, Finland.
- Waddock S.**, Meszoely G., Waddell S., Dentoni D. (2015). *The Complexity of Wicked Problems in Large Scale Change*. Journal of Organizational Change Management 28(6) pp. 993-1012.
- Waldrop M.M.** (1994). *Complexity: The Emerging Science at the Edge of Order and Chaos*. Penguin Harmondsworth, UK.
- Walker B.H.** (1998). *Ecological Resilience in Grazed Rangelands: A Generic Case Study*. In Resilience and the Behavior of Large-Scale Systems pp. 183-194. (Editors: L.H. Gunderson and L. Pritchard). Island Press, Washington, DC.
- Walker B.** (2012). *Applying Resilience Thinking to Resource Management*. Presentation at the Growing Green: Transformation of Farming, Forestry and Fishing Conference. Environmental Defense Society, Auckland, New Zealand. Accessed on 12 January 2018 at: http://archive.edsconference.com/2012_conference.cfm
- 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.
- Walker B.** and Salt D. (2012). *Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function*. Island Press Washington DC.
- Walker B. H.**, Gunderson L., Kinzig A., Folke C., Carpenter S., and Schultz L. (2006). *A Handful of Heuristics and Some Propositions for Understanding Resilience in Social-ecological Systems*. Ecology and Society 11(1) 13.
- Walker J.** and Cooper M. (2011). *Genealogies of Resilience: From Systems Ecology to the Political Economy of Crisis Adaptation*. Security Dialogue. 42(2) pp. 143–160.

- Walklate S., Mythen G., and McGarry R. (2012).** *States of Resilience and the Resilient State*. Current Issues in Criminal Justice 24(2) pp. 185-204.
- Wang G. In-Sue O. Courtright S.H., and Colbert A.E. (2011).** *Transformational Leadership and Performance Across Criteria and Levels: A Meta-analytic Review of 25 Years of Research*. Group and Organizational Management 36(2) pp. 223-270.
- Wang Y. and Ruhe G. (2007).** *The Cognitive Process of Decision Making*. International Journal of Cognitive Informatics and Natural Intelligence 1(2) pp.73-85.
- Wardekker J.A., de Jong A., Knoop J.M., and van der Sluijs V.P. (2010).** *Operationalising a Resilience Approach to Adapting an Urban Delta to Uncertain Climate Changes*. Technological Forecasting and Social Change 77 pp. 987–998.
- Waters D. (2011).** *Supply Chain Risk Management: Vulnerability and Resilience in Logistics*. Kogan Page Publishers, London UK.
- Waugh W.L. (2009).** *Katrina and the Governors*. Public Organization Review 9(4) pp. 343-351.
- Waugh W.L. and Streib G. (2006).** *Collaboration and Leadership for Effective Emergency Management*. Public Administration Review 66(S1) pp. 131-140.
- Wazny K. (2017).** *“Crowdsourcing” Ten Years in: A Review*. Journal of Global Health 7(2) pp. 1-13
- Weaver S.J., Dy S.M., and Rosen M.A. (2014).** *Team Training in Health Care: A Narrative Synthesis of the Literature*. British Medical Journal Quality and Safety 23 pp. 359-372.
- Webb G.R., Tierney K.J., and Dahlhamer J.M. (2002).** *Predicting Long-Term Recovery from Disasters: A Comparison of the Loma Prieta Earthquake and Hurricane Andrew*. Environmental Hazards 4 pp. 45–58.
- Weichselgartner J. and Kelman I. (2015).** *Geographies of Resilience: Challenges and Opportunities of a Descriptive Concept*. Progress in Human Geography 39(3) pp. 249-267.
- Weick K.E. (1993).** *The Collapse of Sensemaking in Organisations: The Mann Gulch Disaster*. Administrative Science Quarterly 38(4) pp. 628–52.
- Weick K.E. and Roberts K.H. (1993).** *Collective Mind in Organizations: Heedful Interrelating on Flight Decks*. Administrative Science Quarterly 38 pp. 357–381
- Weick K. and Sutcliffe K (2015).** *Managing the Unexpected: Sustained Performance in a Complex World*, 3rd edition. John Wiley and Sons Inc, Hoboken, NJ.
- Weick K. and Sutcliffe K. (2007).** *Managing the Unexpected: Resilient Performance in an Age of Uncertainty*. 2nd ed. Jossey-Bass San Francisco, CA.
- Weick K.E. and Sutcliffe K.M. (2003).** *Hospitals as Cultures of Entrapment: A Reanalysis of the Bristol Royal Infirmary*. California Management Review 45(2) pp. 73-84.
- Weick K., Sutcliffe K., and Obstfeld D. (1999).** *Organizing for High Reliability: Processes of Collective Mindfulness*. Research in Organizational Behavior 2 pp. 81-123.
- Wieland A. and Wallenburg V.M. (2012).** *Dealing with Supply Chain Risks*. International Journal of Physical Distribution and Logistics 42(20) pp. 887-905.
- Welsh M. (2014).** *Resilience and Responsibility: Governing Uncertainly in a Complex World*. The Geographical Journal 180(1) pp. 15–26.
- Westerveld E. (2003).** *The Project Excellence Model: Linking Success Criteria and Critical Success Factors*. International Journal of Project Management 21 pp. 411–418
- Westley F. (2013).** *Social Innovation and Resilience: How One Enhances the Other*. Stanford Social Innovation Review 11(3) pp. 28-39.
- Westley F.R., Tjornbo O., Schultz L., Olsson P., Folke C., Crona B., and Bodin Ö. (2013).** *A Theory of Transformative Agency in Linked Social-ecological Systems*. Ecology and Society 18(3) Article 27.
- Westrum R. (2006).** *A Typology of Resilience Situations*. In: Resilience Engineering: Concepts and Precepts pp. 55-65 (Editors: E. Hollnagel, D. Woods, N. Leveson). Ashgate, Aldershot, UK.
- Wheeler D.S. (2015).** *Organization-wide Approaches to Patient Safety*. Innovation and Entrepreneurship in Health 2 pp. 49-57.
- White R.K., Edwards W.C., Farrar A., and Plodinec M. (2015).** *A Practical Approach to Building Resilience in America's Communities*. American Behavioral Scientist 59(2) pp. 200-19.
- Wilbanks T.J. (2009).** *How Geographic Scale Matters in Seeking Community Resilience*. CARRI Research Report No 7. Community and Regional Resilience Institute, Oak Ridge National Laboratory, Oak Ridge TN.
- Wildavsky A. (1988).** *Searching for Safety*. Transaction Books, New Brunswick NJ.
- Wilding N. (2017).** *‘Imagine if’: The Power of Storytelling in Building Business Resilience*. Cyber Security 1(3) pp. 273-284.
- Wilding R. (2006).** *The Application of Complexity Science to Business*. Management Decision 44(7) pp. 837-838.
- Williams T.A., Gruber D.A., Sutcliffe K.M., Shepherd D.A., and Zhao E.Y. (2017).** *Organizational Response to Adversity: Fusing Crisis Management and Resilience Research Streams*. Academy of Management Annals 11(2) pp. 733-769.
- Willis J. (2014).** *Learning Through Feedback Loop Metaphors*. Curriculum Matters 10 pp. 193–213.
- Windle G. (2011).** *What is Resilience? A Review and Concept Analysis*. Reviews in Clinical Gerontology 21(2) pp. 152-169.
- Windle G., Bennett K.M., and Noyes J. (2011).** *A Methodological Review of Resilience Measurement Scales*. Health and Quality of Life Outcomes 9(8) pp. 1-18.
- Witmer H. and Mellinger M.S. (2016).** *Organizational Resilience: Nonprofit Organizations' Response to Change*. Work 54 pp. 255–265.

- Witt A.** and Smith B. (2017). *Enhancing the Resiliency of Small Hydropower Projects: Environmental Function, Modularity, and Stakeholder Elicitation as Design Priorities*. In: World Environmental and Water Resources Congress 2017: International Perspectives, History and Heritage, Emerging Technologies, and Student Papers, (Editors: C.N. Dunn, and B. van Weele).
- Wollenberg E.**, Edmunds D., and Buck L. (2001). *Anticipating Change: Scenarios as a Tool for Increasing Adaptivity in Multistakeholder Setting*. In: Biological Diversity: Balancing Interests Through Adaptive Collaborative Management, pp. 329-347, (Editors: L. Buck, C.C. Geisler, J. Schelhas, E. Wollenberg), CRC Press, Boca Raton Fl. USA.
- Woods D.** (2015). *Four Concepts for Resilience and the Implications for the Future of Resilience Engineering*. Reliability Engineering and System Safety 141 pp. 5-9.
- Woods D.D.** and Branlat M. (2011). *Basic Patterns in How Adaptive Systems Fail*. In: Resilience Engineering in Practice pp. 127–44 (Editors: E. Hollnagel, J. Pariès, Woods D.D., J. Wreathall) Ashgate, Farnham, UK.
- Woods D.D.**, Chan Y.J., and Wreathall J. (2013). *The Stress-strain Model of Resilience Operationalizes the Four Cornerstones of Resilience Engineering*. Proceedings of the 5th REA Symposium: Managing Trade-offs. Resilience Engineering Association, Soesterberg, The Netherlands.
- Woods D.** and Hollnagel E. (2006). *Joint Cognitive Systems*. CRC Press, Boca Raton, FL.
- Wulff K.**, Donato D., and Lurie N. (2015). *What is Health Resilience and How Can We Build it?* Annual Review of Public Health 36 pp. 361-74.
- Wyss R.**, Luthe T., and Abegg B. (2014). *Building Resilience to Climate Change – the Role of Cooperation in Alpine Tourism Networks*. The International Journal of Justice and Sustainability 20(8) pp. 908-922.
- Yano E.T.**, de Abreu W., Gustavsson P.M., and Åhlfeldt R-M. (2015). *A Framework to Support the Development of Cyber Resiliency with Situational Awareness Capability*. 20th International Command and Control Research and Technology Symposium (ICCRTS), Washington D.C.
- Yeung D.** and Martin M.T. (2013). *Spiritual Fitness: A Review of Relevant Constructs, measures and Links to Well-being*. Rand Project Air Force Series on Resiliency. Washington DC, USA.
- Yellman T.W.** and Murray T.M. (2013). *Vulnerability and Resilience*. Risk Analysis. 2013 May 33(5) pp. 753.
- Zhang L.** and Gronvall G.K. (2018). *Red Teaming the Biological Sciences for Deliberate Threats*. Terrorism and Political Violence published online 30 May 2018.
- Zhang Y.**, Lindell M.K., and Prater C.S. (2009). *Vulnerability of Community Businesses to Environmental Disasters*. Disasters 33 pp. 38–57.
- Zhong S.** Clark M., Hou X-Y., Zang Y., and FitzGerald G. (2014). *Validation of a Framework for Measuring Hospital Disaster Resilience Using Factor Analysis*. International Journal of Environmental Research and Public Health 11(6) pp. 6335-6353.
- Zobel C.W.** and Khansa L. (2014). *Characterising Multi-event Disaster Resilience*. Computers and Operations Research 42 pp. 83-94.
- Zolli A.**, and Healy A.M. (2013). *Resilience: Why Things Bounce Back*. Simon and Schuster, New York, NY.
- Zsidisin G.A.** and Wagner S.M. (2010). *Do Perceptions Become Reality? The Moderating Role of Supply Chain Resiliency on Disruption Occurrence*. Journal of Business Logistics 31(2) pp. 1-20.