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Unified Guidelines for Resilience

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Abstract

Social, economic and environmental disturbances threaten industry infrastructure and the security of the products and services we all depend upon. This paper draws together the numerous approaches to resilience-related research and presents guidelines that would reduce the impact of disruptions. This preliminary paper considers streams of research that seek to address the issues of organisational and infrastructural resilience and effective responses to disruptions. The fields of supply chain management (Sheffi, 2005), organisational psychology (Powley, 2009; Barnett and Pratt, 2000), ecology (Walker *et al*, 2002), and strategic management (Hamel and Valikangas, 2003) amongst others, are investigated. This paper firstly considers different definitions of resilience, secondly, it

assess contributions to resilience guidelines and compares approaches in the context of the Worlds current and pressing issues. This work finds many similarities across differing research disciplines. This paper contributes to theory building by establishing a unified set of guidelines with which the impact of infrastructural disruptions could be reduced.

Introduction

On 10th November 2009, 70 million people across Brazil and Paraguay were plunged into darkness for up to 5 hours due to a power supply failure (Conti, 2010). Three transmission lines were cut due to short circuits, all within 20 minutes of each other. How could such a wide geographic area be affected? Was it a failure of technology or some human element? It may conceivably have been any number of issues such as problems with Itaipu, one of the Worlds largest hydro-electric power stations. It may have been a control system failure. It may have been caused by lightning strikes from electrical storms. It may even have been a terrorist attack. These ‘triple incidents’ are not unknown and Hermes Chip, the Director General of the electricity operator ONS, was quoted as saying “no system is designed to support the planning ahead of such remote possibilities. In order to do that, I would need to build a second and maybe a third set of transmission lines to offer the optimum level of redundancy” (Conti, 2010).

The concept of resilience is used in a wide variety of fields ranging from biological and ecological systems to material sciences. If we adopt a systems view of our world, then, it is a chaotic system where small disturbances multiply and produce unpredictable outcomes – long term planning can not ever be definitive (Levy, 1994). Although there is currently a gathering momentum in resilience research, any available guidelines are defined for particular fields of study – no cohesive work is known to exist. Without

guidelines, resilience will only may only ever be a post hoc statement of the response of a system. This preliminary paper reviews some of the key literature across a range of research fields and draws together common ideas, forming them into an elementary, unified set of guidelines. Discussion, further work and conclusions follow.

Literature

Within all fields resilience is directly related to the response of an element or system to a disturbance. Following Cummings *et al* (2005) approach, resilience can be defined as the “ability of the system to maintain its identity in the face of internal change and external shocks and disturbances” .

Environmental ecosystems will continually experience disturbances and perturbations which threaten the persistence and survival of system entities (Petchey and Gaston, 2009). There is an ever-changing biodiversity through the introduction of new species, predation, extinction, changing environmental conditions and fluctuating resources within an ecosystem. This fluctuating biodiversity can have profound consequences on the performance of an ecosystem (Yachi and Loreau, 1999). Subsequently, a resilient ecosystem can be defined as a system that “maintains a general structure, levels of processing, and delivery of services during disturbances” (Petchey and Gaston, 2009). According to Hollings, resilience “determines the persistence of relationships within an ecological system and is a measurement of the system’s ability to absorb disruptions of state variables, driving variables, and parameters, and continue to endure” . This is further developed when considering population and ecological resilience which considers resilience as the rate of return to a pre-disrupted state (Petchey and Gaston, 2009). Resilience within this context could therefore be defined as the ability of a system to recover and return to a stable state following a disturbance or the amount of turbulence a

system can absorb and remain within the bounds or domain of a pre-determined state (Klein et al, 2003). This is interrelated with the systems capability for self-organisation (Carpenter et al, 2001).

Within the field of material science, the resilience of a material is the capacity to absorb energy when deformed elastically and then during the process of unloading, have this energy recovered (Callister, 2003). Resilient materials are those possessing both a high yield strength and a low modulus of elasticity. The associated property is the modulus of resilience, which correlates to the strain energy per unit volume to stress a material from an unloaded state to the point of yielding.

As is shown by this evidence the concept of resilience is closely related with the capability and ability of an element to return to a pre-disturbance state after a disruption. When the notion of resilience is applied to organisations, the definition does not change. Resilience is related to both the individual and organisational responses to turbulence and discontinuities. This involves both the ability to withstand systematic discontinuities as well as the capability to adapt to new risk environments (Starr et al, 2003).

(Riolfi and Savicki, 2003) give their own flavour to the resilience definition by introducing the concept of regressive behaviour “Resilience is a fundamental quality of individuals, groups, organisations, and systems as a whole to respond productively to significant change that disrupts the expected pattern of events without engaging in an extended period of regressive behaviour”.

Organisational resilience has a wide context of factors and is both multidisciplinary and multidimensional (Ponomarev and Holcomb, 2009). Success for organisations has become fragile due to the changing determinants of organisational success (Hamel and Valikangas, 2003). Both internal and external disruptions, for example legal and regulatory actions, terrorist attack, natural disasters and scandals, can all affect the functioning of an

organisation through traditional channels. As a result, Mallak (1998) describes a resilient organisation as an organisation that “designs and implements effective actions to advance the organisation”, it is through this advancement that the organisation is able to increase the probability of its own survival in a turbulent environment. Organisations must therefore strive to ensure future operation and continuity and reach beyond their own boundaries and parameters, and begin to develop an understanding of the intricacies of the environment in which they operate (Fiksel, 2003) as well as developing the attributes required to ensure sustainability. Environmental turbulence and other disruptions that threaten organisational operation and continuity can introduce opportunity as well as risk into the organisational system (Norris et al, 2008). To ensure the success and development of an organisation, the ability to seize potential opportunities and avert or manage threats presented by the external environment is essential.

Low-impact/ high probability disruptive events are an inevitable occurrence within the scope of daily management activities (Sheffi, 2007), as a result the mitigation of these events is well covered within management literature. However, these high-impact/ low-probability events require planning and action outside the normal channels of response.. The impact of these events is further compounded as individuals may have difficulty interpreting low-probability events during the decision making process (Camerer and Kunreuther, 1989). This is possibly through uncertainties being large and difficult to characterise; these high-impact events may therefore affect a system on a wider scale. Subsequently, as Walker *et al* (2002) participatory approach for resilience management in social-ecological systems suggests, individuals should learn to ‘live’ or ‘operate’ within systems instead of striving to control the system. Therefore the definition of organisational resilience is in line with the definition proposed by Sheffi (2007) as “the ability to, and the speed at which an organisation can return to ‘normal’ performance levels following a

high-impact/ low-probability event”. As such resilience is composed of three fundamental components: these are readiness, response and recovery. Table 1 below compares the how the differing disciplines’ researching resilience understand resilience and note the core elements required for guiding organisational and infrastructural behaviour.

Resilience Guidelines

	Guideline	Authors	Research discipline
1	The nature of threat/crisis must be understood Build awareness of resilience issues Understand your environment	Barnett & Pratt (2000) McManus et al (2007) Hamel & Valikangas (2003)	Organisational Organisational Organisational
2	Design appropriate decision socio-technical support systems Perceive experiences constructively Develop decision rules to deal with complexity Develop policy-formulation tools for connecting ecological & socio-economic systems Self-assess vulnerability	Comfort et al (2001) Mallack (1998) Levy (1994) Fiksel (2006) McManus et al (2007)	Complex systems Organisational Strategy Ecosystems Organisational
3	Build-in redundancy measures where possible	Sheffi (2005)	Supply chain
4	Maintenance of decision support systems Perform positive adaptive behaviours Continuous communication Social mechanisms key in resilience	Comfort et al (2001) Mallack (1998) Sheffi (2005) Powley (2009)	Complex systems Organisational Supply chain Human relations
5	Coordination “within and among” organisations Expand decision making boundaries Distributed power/decision making	Comfort et al (2001) Mallack (1998) Sheffi (2005)	Complex systems Organisational Supply chain
6	Adaptive capacity is related to learning Develop collaborative relationships Flexibility and adaptive ability essential Develop mechanism for integrated dialogue between industry, government and academia Develop adaptability across product, enterprise, ecosystem and socio-economic system Learning from others previous experiences Increase adaptive capacity through simulation Must adapt to survive	Carpenter et al (2001) Sheffi (2005) Levy (1994) Fiksel (2006) Fiksel (2003) Crichton et al (2009) McManus et al (2007) Hamel & Valikangas (2003)	Ecosystems Supply chain Strategy Ecosystems Ecosystems Risk management Organisational Organisational

Table 1.

From table 1 above, the greater weight of resilience appears to centre around the concepts of a) designing/developing decision making tools and rules, b) maintenance of mechanisms or preparedness for events and c), adapting to a post-event situations. The area of broadening the scope of decision making amongst networks appears to be something that only Mallack (1998) and Sheffi (2005) have noted as highly important. This would be an interesting area to explore by undertaking empirical studies. Also, the importance of guideline '1', that of clearly understanding the nature of resilience and building awareness of it, seem to be overshadowed by guideline '2', the use of decision making tools – something only the organisational researchers appear to be putting forward..

Conclusions

There does exist great convergence of thought amongst the differing streams of thinking and research that is related to resilience. Drawing these similar ideas together adds strength to the resilience concept and demonstrates its universality and importance to all aspect our world – social, economic and environmental. These guidelines outline the principles necessary for developing a resilient organisational infrastructure. The guidelines highlight the interconnection between research fields, which then aids in developing a complete understanding of the area and the influence of these factors. Establishing linkages between research streams is crucial in understanding the interconnectivity and diverse nature of resilience.

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