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NOTES

The concept of resilience in OSH management: a review of approaches

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The concept of resilience has become very popular, especially in the 21st century. This concept is applicable to many fields, from mechanics to a broad range of social sciences. Resilience has even become part of the national and global policies of the USA, the United Nations and the European Commission. The concept of resilience has also been implemented in the area of safety and health based on the criticism of the traditional approach to occupational safety and health, which does not result in a satisfactory level of occupational safety. The concept of resilience was adopted to research occupational safety and health in different fields and thus with different approaches, such as via socio-technical studies, the psychological and behavioral aspects of organizational resilience and the link with research on individual or family resilience and its influence on work.

Keywords: resilience; occupational safety and health

1. Introduction

For many years, certain researchers and practitioners have claimed that there was a need for a change of approach to occupational safety and health (OSH) because implementations based on the traditional approach did not result in a satisfactory improvement in the level of safety. Moreover, the traditional approach to OSH is not fully compatible with the growing complexity of contemporary organizations and increasing variability of performed processes inside these organizations and in the environment outside them, given that the traditional approach considers variability of performance to be a possible threat. Resilience, believed to be an important property of complex and continuously changing systems and/or an ability to cope with diversity, is claimed to be a good answer to the needs of contemporary organizations.

Although the concept of resilience has gained in popularity over the course of this millennium, it has a somewhat long history. According to Alexander, the word passed into English via Middle French, with the meaning ‘to retract’ or ‘to cancel’. The term ‘resilience’ was then used with the meaning of ‘rebounding’, while from the 19th century the term was also used to signify the ability to recover from adversity.[1] According to McAslan,[2] resilience was introduced into scientific terminology in that century, when it was first used to describe a property of timber.

However, it is generally believed that the current popularity of resilience results from its adoption in modern science through ecology as a result of the works of C. S. Holling, who defined resilience as the capacity to continue to exist in a domain in the face of change.[1,2] He proposed

that ‘resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist’.[3,p.14] Since then, the concept of resilience in ecology has been vigorously discussed.

Currently, the term ‘resilience’ is present in many fields, from mechanics to a broad range of psychological [4–9] and social sciences.[9–12] Some research on resilience even focuses on areas such as urban resilience,[13] the education system [14] and organized crime.[15]

The concept of resilience has been adopted in the policies of numerous governments, including those of the USA and Canada; it has also been adopted by the United Nations, as the development of resilience in national and global resilience has been set as a priority for global safety policy.[16–18] The European Commission has defined its approach to resilience on the global level, e.g., in the ‘Communication from the Commission to the European Parliament and the Council. The EU Approach to Resilience: Learning From Food Security Crises’.[19]

The concept of resilience has also been studied on the organizational level. The concept of the resilience of organizations was originally used to describe the need to respond to changes in the business environment.[2] Thus, the concept of resilience was originally used to show the need for properties such as flexibility, adaptability and agility to change following environment changes.[20] Since that time, focus has shifted to disruptive events and catastrophes because effective management during a crisis

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or disaster may be key to success or collapse (many examples of companies facing unexpected incidents or disasters are given by Sheffi [21]). Organizations need to be prepared for effective crisis management. According to Seville et al., each organization has own 'perfect storm' that may cause adversity for any organization,[22] and resilience is what allows an organization to survive or even to prosper, to turn 'challenges into opportunities'. [23,24] While most organizations have plans and schemes that address risk, crises, adversity and even disasters, they are typically managed in isolation from one another, resulting in gaps or wasted resources through overlaps, while organizational resilience aims to bring these tasks and activities together as a single process, one that resides at the very center of an organization's management ethos and way of operating.[25]

Rapid developments in the concept of resilience and its growing popularity have resulted in the introduction of national standards for resilient organizations in some countries. For example, in the USA, ASIS International has prepared Standard No. ASIS SPC.1-2009.[26] Other countries are also introducing or preparing national standards on resilience. In 2011, the first International Organization for Standardization (ISO) standards on resilience were issued (Standard No. ISO 28002:2011 [27]). ISO guidelines on organizational resilience are being prepared.

The concept of resilience is adopted to research OSH from different fields and thus with different approaches, e.g., via socio-technical studies (e.g., [28]), the psychological and behavioral aspects of organizational resilience [29] and the link with research on individual or family resilience and its influence on work,[9] which is why the different definitions of and attitudes to resilience applied to the different scientific fields cited in this article should help to understand the nature of resilience in OSH.

2. Definitions of resilience

The wide range of fields in which the concept of resilience has been independently applied, together with the large number of approaches, makes defining resilience difficult and problematic. The multitude of uses and interpretations may lead to confusion. When we keep in mind that resilience is defined, depending on the object of research, as a property of material, ecological and social (and other) systems, individuals (in different roles), families, teams, communities, organizations, nations and states, this difficulty is obvious. However, 'a variety of definitions can exist as long as they are acknowledged and there are people who can translate between them'. [30,p.2]

Resilience was first defined in the field of the mechanics of materials as the ability of a material to absorb energy when it is elastically deformed and to release that energy upon unloading. When the concept of resilience was adopted by social, thus 'non-material', sciences, the original meaning simply became a type of metaphor.

As already noted, resilience was introduced to ecology by Holling, who formulated the ecological definition of resilience. Following intense discussion, over the years many definitions of ecological resilience were introduced together with many approaches and interpretations. Some of them were combined by McAslan [2,p.4]:

- Holling, 1973: The resilience of an ecosystem is the measure of the ability of an ecosystem to absorb changes and still exist.
- Pimm, 1984: Resilience is the speed with which a system returns to its original shape.
- Holling et al., 1995: Resilience is the buffer capacity or ability to absorb perturbation or the magnitude of the disturbance that can be absorbed before a system changes its structure by changing the variables and processes that control behavior.
- Alwang et al., 2001: Resilience is the ability to resist downward pressure and to recover from shock. From the ecological literature, it is the property that allows a system to absorb, use and even benefit from change. Where resilience is high, it requires a major disturbance to overcome the limits to qualitative change in a system and allow it to be transformed rapidly into another condition.
- Walker et al., 2002: Resilience is the potential of a system to remain in a particular configuration and to maintain its feedback and functions, and it involves the ability of the system to reorganize itself following the disturbance-driven change.
- Cardona, 2003: Resilience is the capacity of the damaged ecosystem or community to absorb negative impacts and recover from them.
- Stockholm Resilience Centre, 2009: Resilience refers to the capacity of a social-ecological system both to withstand perturbations from, for instance, climate or economic shocks and to rebuild and renew itself afterwards. The loss of resilience can cause the loss of valuable ecosystem services and may even lead to rapid transitions or shifts into qualitatively different situations and configurations, evident in, for instance, people, ecosystems, knowledge systems, or whole cultures'.

Resilience has thus been treated as a measure of capacity or as a type of capacity itself, speed, ability or potential.

As in the case of ecological research, there has been little consensus on what exactly resilience means in psychology. Individual resilience has been defined, e.g., as follows:

- 'both the capacity to be bent without breaking and the capacity, once bent, to spring back' [31,p.248];
- 'the skills, abilities, knowledge, and insight that accumulate over time as people struggle to surmount adversity and meet challenges' [32,p.298];

- ‘the capacity to maintain competent functioning in the face of major life stressors’ [33,p.158];
- ‘the successful adaptation to life tasks in the face of social disadvantage or highly adverse conditions’ [34,p.163];
- ‘the ability of adults in otherwise normal circumstances who are exposed to an isolated and potentially highly disruptive event, such as the death of a close relation or a violent, life-threatening situation, to maintain relatively stable, healthy levels of psychosocial and physical functioning as well as the capacity for generative (i.e., capable of reproduction) experiences and positive emotions’ [5,p.20]; and
- ‘a dynamic process that involves a personal negotiation through life that fluctuates across time, life stage and context’.[35,p.6]

Except for the main idea of facing challenges, it is somewhat difficult to guess that all of those definitions concern the same subject. Thus, there is also little consensus on individual resilience in practice, especially in clinical practice. Regardless, some researchers attempt to find commonalities. Barnard identifies the following nine individual phenomena that the literature has repeatedly shown to correlate with resiliency: (a) being perceived as more cuddly and affectionate in infancy and beyond; (b) having no sibling born within 20–24 months of one’s own birth; (c) a higher level of intelligence; (d) the capacity and skills for developing intimate relationships; (e) achievement orientation in and outside school; (f) the capacity to construct productive meanings for events in individuals’ worlds that enhance their understanding of these events; (g) being able to selectively disengage from the home, engage with those outside and then to re-engage; (h) being internally oriented and having an internal locus of control; and (i) the absence of serious illness during adolescence.[36,p.139–140]

Recent years have raised an interest in coping with disasters and other disruptive large-scale events, and psychological research is therefore also more focused on this type of resilience. However, numerous studies on disasters and the people facing them show that there are different types of reactions to such events, and some researchers claim that resilience is one such possible reaction. For example, Carver suggests that resilience is one of four possible reactions to adversity, together with thriving, survival and succumbing.[37] McAslan defines two issues that are generally agreed upon:

- the issue of adaptability, where ‘individuals who are able and willing to adapt are more likely to reduce their risk of being exposed to similar disruptive events, or at least to reduce the impact of such exposure; resilient individuals are likely to be able and willing to adapt’; and

- the issue of transient dysfunction, where ‘the absence of dysfunction or distress in an individual suggests resistance rather than resilience . . . However, dysfunction or distress is temporary, followed by a return to normal functioning’.[2, p. 5]

There are many definitions of resilience in the field of organizational and national and global resilience studies. Unlike the definitions in the cases of ecology and psychology, they seem to be more consistent and similar. However, they are formulated as very broad and theoretical constructs that leave open a great possibility of interpretation in relation to practical use. Certain resilience specialists admit that organizational resilience is difficult to define.[38,39] The level of difficulty is high because what resilience means may vary depending on the approach, current needs, threats and the organization itself.

However, defining national and organizational resilience is facilitated, at least on a theoretical level, by the fact that, together with scientific definitions, there are also definitions that have been created for the purpose of legal solutions and cooperation on the national and international levels and for the needs of national standards.

The United Nations defines resilience as follows:

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. Comment: Resilience means the ability to ‘resile from’ or ‘spring back from’ a shock. The resilience of a community in respect to potential hazard events is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need.[17,p.24]

The European Commission states:

Resilience is the ability of an individual, a household, a community, a country or a region to withstand, to adapt, and to quickly recover from stresses and shocks. The concept of resilience has two dimensions: the inherent strength of an entity – an individual, a household, a community or a larger structure – to better resist stress and shock and the capacity of this entity to bounce back rapidly from the impact. Increasing resilience (and reducing vulnerability) can therefore be achieved either by enhancing the entity’s strength, or by reducing the intensity of the impact, or both.[19,p.5]

The US Department of Homeland Security defines resilience as the ‘ability to resist, absorb, recover from or successfully adapt to adversity or a change in conditions’ and also provides the following extended definition:

(1) ability of systems, infrastructures, government, business and citizenry to resist, absorb, recover from, or adapt to an adverse occurrence that may cause harm, destruction, or loss of national significance, (2) capacity of an organization to recognize threats and hazards and make adjustments that will improve future protection efforts and risk reduction measures.[40,p.23–24]

In the case of companies and organizations, the definitions of resilience were formulated in national standards. According to Standard No. ASIS SPC.1-2009,[26,p.48] resilience is ‘the adaptive capacity of an organisation in a complex and changing environment’. Two additional notes are given, stating that (a) ‘resilience is the ability of an organisation to resist being affected by an event or the ability to return to an acceptable level of performance in an acceptable period of time after being affected by an event’ and (b) ‘resilience is the capability of a system to maintain its functions and structure in the face of internal and external change and to degrade gracefully when it must’. Based on Standard No. ASIS SPC.1-2009,[26] Standard No. ISO 28002:2011 was also developed.[27]

Because there are so many approaches that scientists and practitioners take to define resilience, Longstaff et al. [30] have attempted to systemize them using the Multidisciplinary Resilience Framework, based on the level of complexity and normativity. Those authors define four types of approaches to resilience:

- Type I: resilience as the capacity to rebound and recover, where resilience is seen as a pure ‘measure of elasticity against perturbations and the rapidity of recovery’;
- Type II: resilience as the capacity to maintain a desirable state, regarding resilience ‘as something positive and bouncing back to an approved equilibrium proves the existence of reliance’;
- Type III: resilience as the capacity of the system to withstand stress, describing ‘resilience as the relationship between the current system state and a potential system shift that will flip the system into a different state’;
- Type IV: resilience as the capability to adapt and thrive, underlining ‘the existence of multiple possible states’ but also calling for ‘successful adaption before or after a disturbance occurs’. This approach assumes the possibility that the post-disturbance state may even be better.[30,p.6–7]

3. OSH and resilience

The application of the concept to the field of OSH seems to be a natural result of both research on resilience in various fields, including organizational studies, disaster studies and psychology, and the fact that research on resilience involves interest in problems such as safety, danger, stress, adversity, recovery, disturbance and disaster. The concept of resilience corresponds well to ideas such as the need for proactivity, anticipation and the need to reformulate the traditional approach to safety because it allows, at some point, a limited increment of safety.

Some approaches to resilience concerning safety and health focus on the psychological and behavioral aspects

of resilience and the organization and on the influence of the individual on performance in terms of resilience and on individual resilience itself. For example, Kamphuis and Delahajj present a psychological resilience model of the Netherlands Armed Forces.[41] A specific approach to the evaluation of resilience has been implemented in Quebec, Canada, as a result of work of the Resilience Subcommittee of the Organization of Civil Protection in Quebec (OSCQ). It is based on a four-step methodology that includes (a) the portrait of a system, (b) the study of outputs and inputs, (c) the management of failures and (d) the evaluation of resilience. Han et al. propose the use of a simulation and visualization method with the use of cameras that monitor and then measure a worker’s behavior, meaning that behavioral sampling together with the dynamic safety culture model constructed for the system would be the basis for resilience assessment.[42]

Research conducted by Affinity Health at Work, which considered organizations from a psychological perspective and regarded resilience as being dependent on the social or environmental context, defined the following categories as crucial for resilience [29]: (a) job design (resilience can be developed by focusing on a person’s role and how non-monetary rewards may contribute to reducing stress and motivate a person); (b) leadership (focusing on the role of leadership in resilience and how it may promote resilience); (c) organizational structure and culture (resilience interventions using processes and organizational culture to best equip organizations to face challenges); and (d) systemic/external environment (interventions that use risk management and assess risk by examining external factors and threats). Clearly, individuals – and especially leaders – play an important role. Together with such tools as traditional OSH tools (e.g., risk assessment, education, crisis management, risk assessment), the author suggests work on individual and team resilience and a stronger focus on leaders and their role in resilient organizations.

The work of VanBreda is an example of yet another approach. As a social worker, he investigates resilience at work as being strictly linked with the personal situations of workers, and his fields of interest are mainly families and the community. He uses the concept of the ‘work–life interface’ to refer to the often conflictual relationship between the occupational or work role/system and the personal ‘life’ or family roles/systems of people.[9] This approach also assumes that, despite the common assumption, family and work are not two separate worlds. Thus, resilience at work is strongly influenced by the quality of the individual’s personal/family life. VanBreda also emphasizes the role of culture, gender, religion, community and other factors for resilience.

The best known and developed approach to resilience in relation to OSH is most probably resilience engineering, which mainly originated from research on the functioning

of complex socio-technical systems. This approach is based on the assumption that safety is not ‘freedom from risk’ but rather:

the ability to succeed under varying conditions. It is a consequence of this definition that it is equally important to study things that go right as things that go wrong. For resilience engineering, the understanding of the normal functioning of a socio-technical system is the necessary and sufficient basis for understanding how it fails. And it is both easier and more effective to increase safety by improving the number of things that go right, than by reducing the number of things that go wrong.[43,p.xxix]

This approach considers variability and changes inside and outside an organization as normal and necessary and as a source of positive and negative outcomes, not as a threat.

According to Hollnagel, resilience engineering regards the ‘things that go wrong’ as the flip side of the ‘things that go right’ because they are both the results of the same underlying processes: ‘In consequence of that, “things that go right” and “things that go wrong” should be explained in basically the same way’.[43,p.xxxiii] Hollnagel and Woods define resilience engineering as ‘a paradigm for safety management that focuses on how to help people cope with complexity under pressure to achieve success’.[44,p.6] The authors claim that ‘it strongly contrasts with what is typical today – a paradigm of tabulating error as if it were a thing, followed by interventions to reduce this count’. Grøtan describes resilience engineering as asking the question ‘why does it work’ rather than ‘why does it fail’.[45]

Hollnagel uses the concept of Safety II as opposed to Safety I, understood as avoiding what goes wrong. The concept of Safety II defines safety management as a tool to ensure that ‘as much as possible goes right’, which means that safety is managed by achievements and, consequently, is measured by counting the number of cases where things go right, not merely by the number of failures. Of course, this approach does not mean that traditional measures are unnecessary, but they are simply considered to be part of safety management.[46]

For the purpose of resilience engineering theory, Hollnagel defined resilience as the ‘ability of a system or an organization to react and recover from disturbances at an early stage, with minimal effects on dynamic stability’.[47,p.16] This definition was enhanced by Woods, who formulated four properties of resilient systems: buffering capacity, flexibility, margin (between operation and the performance boundary) and tolerance (the system’s behavior near the boundary).[48] Hale and Heijer described resilience as ‘an ability to steer the activities of the organisation so that it may sail close to the area when accidents happen, but always stays out of that dangerous area’.[49,p.36] Leveson et al. defined resilience as follows: ‘resilience is the ability of systems to prevent or adapt to changing conditions in order to maintain (control over) system property’.[50,p.95]

Westrum provides a typology of resilience situations for the purpose of resilience engineering. Considering the nature of the threats to the integrity to the system, he defines three possibilities: a regular threat, an irregular threat and an unexampled event. Resilience situations are always divided depending on where the event falls on the organization’s time horizon. From this perspective, Westrum defines three possibilities: foreseeing and avoiding, coping with ongoing trouble and repairing after catastrophe.[51] Wears and Morrison propose three levels of resilience: a negative feedback loop (the system responds to reduce deviation), a response to disturbance that is either unexampled or not managed at level 1 (and involves trade-offs and sacrifice decisions) and learning from relevant feedback obtained during the response.[52]

Hollnagel notes that:

the definition of resilience can be made more concrete by pointing to four abilities that are necessary for a system to be resilient. These are the ability to respond to events, to monitor ongoing developments, to anticipate future threats and opportunities, and to learn from past failures and successes alike.[48,p.xxix]

The so-called four cornerstones are one of the fundamental concepts of resilience engineering. These cornerstones are as follows:

- knowing what to do (responding to actual/regular disruptions and disturbances);
- knowing what to look for (monitoring the critical);
- knowing what to expect (anticipating the potential); and
- knowing what has happened (learning from experience).[48]

Resilience management is thus defined as managing the four core processes that are critical to the resilience of an organization:

- Responding, which requires preparedness based on right anticipation. Paries notes that resilience requires a combination of readiness and creativity, anticipation and serendipity. The crucial idea is that nothing can be anticipated in every detail; thus, what the organization needs is ‘being prepared to be unprepared’. To visualize this concept, Paries uses the example of landing on the Hudson River and the entire decision-making during this operation.[53]
- Monitoring: Wreathall emphasizes the role of proactivity and the anticipation of major changes in safety and other critical performance domains. He claims that, for resilient organizations, data on performance are needed ‘not just from outputs of the processes but from intermediate activities along the way’.[54]
- Anticipation: Woods provides six patterns that describe the anticipating abilities of resilient systems: (a) resilient systems are able to recognize

that adaptive capacity is falling or inadequate to the contingencies and squeezes or bottlenecks ahead; (b) resilient systems are able to recognize the threat of exhausting buffers and reserves; (c) resilient systems are able to recognize when to shift priorities across goal trade-offs; (d) resilient systems are able to make perspective shifts and contrast diverse perspectives that go beyond their nominal system position; (e) resilient systems are able to navigate interdependencies across roles, activities and levels; and (f) resilient systems are able to recognize the necessary ways to adapt.[55]

- Learning, based on the paradigm that the organization must learn from what is both right and wrong.

Trade-offs are another fundamental part of resilience engineering theory.[56] Rigaud and Martin systemize trade-offs and also define the fields affected by specific trade-offs:

- ‘Acute–chronic’ trade-offs, which affect an agent’s perceptions of the normal and abnormal functioning of the system, the criticality of situations, the response plan and adaptation to unanticipated situations, the nature of indicators, measurement frequency, the criticality of variability in indicators, the potential consequences of change and innovation for risk and the ability to respond, the ability to identify new threats and opportunities, the choice of relevant situations for learning, the ability to identify a diversity of lessons from situations and the ability to learn lessons.
- ‘Efficiency–thoroughness’ trade-offs, which affect the availability of time, knowledge, information and resources: to detect an abnormal situation, to recognize the situation, to consider the criticality of the situation and decide to respond and to respond, to collect data, evaluate and analyze indicators, for change and innovation identification, for change management and risk and opportunities analysis and to study situations and learn from the results of investigations.
- ‘Specialist–generalist’ trade-offs, which affect the communication capacity between units and the variability in a unit’s perspective on the criticality of situations.
- ‘Distributed–concentrated’ trade-offs, which affect the communication capacity between units.
- ‘Optimality–fragility’ trade-offs, which affect the safety culture and safety barriers.[57]

In general, because resilience itself is believed to be difficult (or impossible) to measure directly, resilience engineering proposes various tools based on the measurement of the four main abilities (cornerstones). Hollnagel proposes the Resilience Analysis Grid (RAG).[58] This

tool is a questionnaire consisting of four sets of questions (one set dedicated to each cornerstone). Hollnagel emphasizes that all four cornerstones are necessary to ensure the appropriate resilience level; thus, a low level of performance in one cornerstone cannot be compensated by a high level in another cornerstone. Woods et al. present the Stress–Strain model of resilience,[59] proposed originally by Woods and Wreathall, as a tool for using the RAG in the concept and visualization that the Stress–Strain model provides.[60] This model is almost directly based on the stress and strain relationships described by the mechanics of materials. Of course, there are other proposals that aim to improve the RAG. For example, based on the four main abilities (cornerstones), Rigaud and Martin define 11 abilities as key indicators of resilience and simultaneously integrate trade-offs into the analysis.[57] Furthermore, there are other proposals and models for the assessment of resilience [61,62] and also for other purpose, including, e.g., assessing OSH systems from the resilience engineering perspective.[63]

The resilience engineering approach is very socio-technical and clearly concentrates on processes and resources. However, the human role is clearly seen in such fields where resilience is directly connected with one individual’s decision, as in the case of pilots and air traffic controllers (e.g., [53,64]). The advantages of resilience engineering are a large number of case studies and the strict connection with practice. Moreover, definitions and tools are formulated so generally that it can be easily adopted by many fields of activity.

4. Discussion

The increasing popularity of resilience, together with the number of fields to which it is applied, has resulted, quite naturally, in rising criticism of resilience theory itself and/or its application to specific scientific fields. First, the criticism is aimed at the definition of resilience. It is an obvious target because, even within certain scientific fields (e.g., ecology and psychology), there is no compromise on what exactly resilience is, especially in terms of a multidisciplinary definition.

Kaplan, cited by McAslan, criticizes the entire concept:

the deceptively simple construct of resilience is in fact rife with hidden complexities, contradictions and ambiguities. Arguably, any consensus that exists regarding the nature of resilience rests upon the idea of the achievement of positively (or the avoidance of negatively) valued outcomes in circumstances where adverse outcomes would normally be expected. A close examination of this idea, however, reveals a number of unresolved questions that at best render the concept less than useful, and at worst impede progress in understanding human adaptation.[65,p.9]

Alexander suggests that some discomfort may result from the very wide scope of the definition, especially if the term is pushed to represent more than it may deliver.[1]

Luthar et al. note the lack of clarity and consistency of definitions and also conclude that there is clearly a need for resilience researchers to enhance the scientific rigor of their work.[66]

There are many voices representing various scientific fields claiming that different types of systems with different origin (e.g., ecosystems and social systems) are operating in ways which are so different that a theory concerning one type cannot be directly applied to another [67]; while Davidson argues that resilience theory offers some promise, but it is completely inapplicable to the social sciences.[68] Resilience theory has been even attacked for being a concept that promotes and excuses the *status quo* of contemporary neoliberal capitalism.[69,70]

Lewis et al. list many gaps in and limitations to resilience theory and research, including inconsistencies in approaches and the lack of an agreed-upon conceptual framework, including the lack of an exact definition. They also note the lack of attention to social/cultural contexts and the little attention to organizational culture, and underline the fact that most research is USA-centric, meaning that socio-cultural differences should be taken into account. It is also emphasized that ‘there is no distinction in studies between small, medium and large organisations, nor is there clarity about whether they were in the private, public or third sector’.[29,p.7] Some remarks on culture differences were expressed also by Bracco et al. because they present problems and obstacles resulting from differences in political, cultural and normative systems.[61] More generally, some researchers noted the importance of a multidimensional and longitudinal approach to resilience (e.g., [66,41]).

McDonald raised certain doubts concerning resilience engineering. He defined problems such as the reliance on *post hoc* analysis of past events, the loose theoretical concept, the wrong diagnosis or predictions and relying on generalized metaphors as explanatory principles. McDonald also asked whether the popularity of resilience engineering has resulted from the real power of the theory or from the weakness of other models. An evaluation matrix was presented, in which resilience theory was assessed as very weak in terms of theoretical power and as completely unprepared in terms of technology readiness. It must be added that, since that time, the theory of resilience engineering has been much developed.[71]

Both resilience engineering and the concept of resilience itself are defined widely enough to easily link them with other approaches to OSH management. For example, Gallis and Zwetsloot [72] describe the concepts of resilience engineering and the high-reliability organization as ‘closely related approaches providing a new vision on risk management’, and they list the ‘commitment to resilience’ as one characteristic of high-reliability organizations, citing Weick and Suttcliffe, who define the commitment to resilience as one of five practices for developing the ‘mindfulness’ of an organization.[73]

Despite these doubts and the lack of clarity, resilience remains attractive in fields that cope with complexity, unpredictability and changes which lead to threats and sometimes even to danger. The weak points of resilience theory in the field of OSH are the same as in other fields: the unclear definition and the question of how resilience shall be measured. However, most studies on resilience engineering concentrate on the practical problems of organizations. Certain weak points of resilience theory in the field of OSH result from the fact that its development began only a few years ago and it needs some time to mature.

To summarize, it is noteworthy that there are many voices on the concept of resilience as a revolution in safety management, including the announcement of a new era in safety.[74] However, a detailed analysis leads to the conclusion that the change is not as large as it seems. Hollnagel et al. state that ‘resilience engineering differs more in the perspective it provides on safety than in the methods and practical approaches that are used to address real-life problems’.[75,p.9]

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