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Being Resilient in Challenging Times in Food Supply Chains †

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Abstract: Resilience has been described in many ways and in this paper is considered as the ability of an organization or wider food supply chain to not just 'bounce back' to a steady state, but to 'bounce forward' or 'bounce without breaking' to a new sense of becoming that is continually reshaped by the evolving environment. This keynote-positioned conceptual paper reflects aspects of resilience that will be considered during the conference. Resilience as a concept can be framed in the context of food supply chains in terms of the triad of natural systems resilience, organizational resilience, and personal resilience. The main focus of this paper is on organizational resilience and developing the capacity to buffer shocks and to adapt to changing supply chain drivers and demands as the world in which the organization operates becomes more uncertain. One infrastructural approach to improving adaptive capacity, as a result resilience, is the integration of digital technologies and smart systems into food supply chains, what is often described as Industry 4.0.

Keywords: resilient; food; supply chains; food system; shocks; challenges; complexity; buffer; adaptiveness; Industry 4.0

1. Introduction

Resilience as a concept has been defined in many ways in the literature depending firstly on the initial academic discipline from which the application arises (engineering, ecology, business management and so forth) and how the conceptualization is then applied to food supply chains in particular. First, there is the "business as usual" view of resilience, i.e., after a supply chain shock, resilience is the ability of a business, supply chain or a system to return to its original stable state [1–4]. Alternatively, the "bounce forward" view of an organization focuses on resilience as being the taking of opportunity after a disturbance and to transition to a new, more desirable state [1], and then resilience is conceptualized as an organization being perceived as being resilient when it has the transforming capacity to change, renew and grow [5–7].

Generally, considerations of resilience reflect an understanding that there is no steady state, that systems, especially food systems, are dynamic and ever changing, and operate within an environment that is uncertain [6], and increasingly so. Therefore, embedding the capacity to adapt and transform to new often non-linear conditions is essential [5,6]. Indeed, organizations, or whole supply chains, that have the core competencies to capture opportunities that arise from system disturbance and outperform others who fail to adapt can be described as being resilient [8,9] rather than being vulnerable [10], i.e., to 'bounce without breaking' [9].

Organizations, food supply chains and wider food systems are intrinsically complex and diverse. Food systems are composed of multiple activities, processes, value chains, actors, interactions both internal and external to the commercial relationships, and the impact of these activities affect multiple stakeholders in diverse and sometimes conflicting ways [11]. Therefore, food system resilience can be described as "the capacity over time of a food system, and its units at multiple levels, to provide sufficient, appropriate and

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accessible food to all, in the face of various and even unforeseen disturbances" [11] (p. 19). This definition suggests both a spatial aspect and a temporal aspect to resilience, in that shocks can be singular or multiple, both over time, and in their single or multiple foci in a food system. Shocks, economic disruption, wars and conflicts, harvest failure, supply issues, consumer boycotts of particular foods or organizations, and so forth, can influence, at different levels, the food system. Macro shocks define those shocks that influence at the supranational, national, regional or supply chain level; meso shocks at the organizational level; and micro shocks at the individual and personal level [12]. The multiplicity and complexity of interactions of such shocks is beyond exploration in this short paper.

Multiple shocks, or their associated ascribed magnitude of risk, can come together in a non-linear, complex event to produce an accumulated magnitude of risk and associated impact(s) that collectively could be greater than if the individual risks had occurred independently [13]. This non-linear aggregated and complex event has been termed a "perfect storm" [14]. Ref. [13] (p. 291) describes a perfect storm as "a combination of uncertainty, and aggregated "risky events with singular and multiple negative outcomes occurring simultaneously." Therefore, whilst risk assessment processes can assess single, independent risks associated with shocks and prioritize them in terms of their management and possible elimination, the level of dependency and interdependency between these events is difficult to determine [14], and, as a result, the aggregated risk of a multiple shock event occurring, its severity should it occur and the impact on the organization and wider supply chain is difficult to accurately compute, if such models actually exist.

Resilience, buffer capacity, adaptive capacity and redundancy are important elements. Buffer capacity represents the ability of an organization to utilize its resources (financial, physical, natural, human and social) to withstand a shock [8,9]. Adaptive capacity is the ability to adapt and change in the event of a shock, and the third element redundancy or substitutability [11] is also important. There are two elements to redundancy: firstly, being able to anticipate a shock/simultaneous shocks; and secondly, being prepared for a disruptive event, e.g., by having a business continuity plan in place [15]. The main focus of this paper is on organizational resilience and developing the capacity to buffer shocks and to adapt to changing supply chain drivers and demands. Section 2 explores adaptive capacity, panarchy and resilience in more detail and Section 3 provides some concluding thoughts.

2. Adaptive Capacity

Adaption can occur at the enterprise, organizational or supply chain level and involves a realigning, reconfiguring or reassorting of resources requiring the sacrificing of individual aspects of practice to deliver overall organizational resilience [6]. These adaption responses can be planned, or can be spontaneous, and can either be short-term tactics or long-term strategies. Thus, there is a difference between potentially transient adaptive responses and transformative activities that lead to long-term resilience [5,6]. The concept of panarchy positions resilience in terms of multiple interventions and associated interactions (both intended and unintended; positive and negative) that operate at a range of inter-level and intra-level loci (micro, meso, macro), horizontally and vertically (top-down, bottom-up, or peer-to-peer, often simultaneously), and where thresholds exist that can trigger feedback loops [16,17].

A panarchy forms as an interaction of adaptive cycles interlinked and crosslinked "across different levels on scales of time, space, and meaning," at the supply chain level, the political-economic level, and the planetary level [18] (p. 58). Two main cross-linkages are described by [18] as 'remember' and 'revolt' that interface with elements of panarchy, including reorganisation, exploitation, conservation and release [19–21]. Thus, the adaptive cycle is formed of four phases: growth (exploitation), conservation, collapse (release) and reorganization [22]. The concept of panarchy reflects system adaptability and system connectedness, but a further element of resilience is system-level temporal and spatial trade-offs, e.g., temporal aspects of using resources now or conserving for the future and

spatial aspects such as distance between actors in a food supply chain and the impact of resilience on the situational characteristics of suppliers and the logistical implications [23]. These examples show the need for a more expansive and adaptive framing of food supply chains rather than a reductionist and static view [18]. Organizational and supply chain resilience relies on socio-technical mechanisms of release and reorganization, learning, relearning, unlearning, [24] acceptance or revolt, especially with the uncertainty created by contemporary shocks such as the COVID-19 pandemic, the Ukraine–Russia conflict, climate change, global warming, the rate of technological and institutional change, innovation or even revolution [25], both implicitly, and also how mitigation processes themselves impact food supply chains. In essence, for food supply chains to be resilient, they need to be less static, ridged and brittle, and instead more responsive, adaptive and able to buffer and adapt to shocks. Connectedness can both improve resilience, but be a vulnerability in of itself, if connectedness drives rigidity [25]; so, when considering 'bouncing back' or 'bouncing forward', the requisite state of equilibrium and what that 'looks like' is important [26].

Diversity supports ecological and socio-economic framings of resilience [23]. Diversity is the degree of variability in terms of functional diversity (integral components or functions [23]), and cognitively the variability through strategic responses to positive and negative triggers, internal or external to the system. Variety and diversity influence organizational equilibria, the thresholds at which shock(s) impact(s), and the application of remembering as a response mechanism. Constraints include organizational memory influencing adaption [26], the variety of outcomes and how they are influenced by the variety of activities employed to deliver these outcomes [27]. The introduction of Industry 4.0 into food supply chains has been positioned as a means to mitigate supply chain disruption through increasing agility [28]. Being adaptive and being resilient are a complex interaction of these interconnected mechanisms that are heavily influenced not only by the components and their functionality within the system, but also how those components are connected within socio-economic and socio-technical levels, and how they are connected across these levels.

3. Concluding Thoughts

Resilience has been described in many ways and in this paper is considered as the ability of an organization or wider food supply chain to not just 'bounce back' to a steady state, but to 'bounce forward' to a new status that is shaped by the evolving environment. Organizational resilience at the system level is presented in a non-linear and non-static view with the system being seen as "becoming" in terms of transformational aspects rather than simply "being" with regard to its transactional aspects [18]. Thus, resilience as a state and in terms of organizational thinking requires organizations, and indeed whole supply chains, to develop mechanisms that are firstly framed by the structures and connections, both physical and digital, that allow the organizations to operate in a dynamic environment, secondly, utilizes organizational memory and knows when to disregard it when it is a barrier to survival, and, finally, can embrace and grow through revolution whether it be social, technological or geopolitical. This notion of resilience reflects that there is no steady state, no business as usual, that 'bouncing back' or 'bouncing without breaking' is not a position which embraces all opportunity, and even 'bouncing forward' is not an end in itself, but only a transient position.

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