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Driving organizational sustainability-oriented innovation capabilities: a complex adaptive systems perspective

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Innovation capabilities are considered a crucial ingredient for organizations in order to drive sustainable organizational transformations in turbulent business environments. The impact of information technology (IT) as a force of sustainability and innovation received a renewed interest as a means of achieving boundary-spanning arrangements. This interplay between the changing competitive landscape, collaboration forms with partners, and IT as a facilitator, are considered the cornerstones of sustainability in organizations. The aim of this study is to understand how IT flexibility, partner collaborations, and environmental business factors lead to enhanced sustainability-oriented innovation capabilities. Outcomes suggest that IT should be approached as an adaptive vehicle in the process of creating social and economic value to relevant stakeholders in the business ecosystem.

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Introduction

Modern organizations across a wide range of industries are currently exploring new innovative digital technologies in order to deal with a multitude of challenges, and as a crucial determinant of survival in a competitive and turbulent setting [1,2]. On the basis of extant literature, we know that many organizations face strong pressure to improve customer efficiency and effectiveness, transform toward environmentally sustainable work practices, use green technologies and drive organization-wide innovations through improved collaboration and, hence, improve their evolutionary fitness [3•,4••,5•]. The adoption, effective use, and alignment of information systems and information technology (IS/IT) are critical in this respect [4••,6,7,8•,9]. It is within this context that scholars have coined the term 'IT capabilities' as an attempt to measure organizations' proficiency in exploiting their IT asset base. IT capabilities are enterprise-wide capabilities that leverage technology to differentiate from competition [10]. It has been suggested that a specific constituent of IT capabilities, namely the flexibility of an IT infrastructure, determines the value of that infrastructure to organizations [11]. Recent studies have tight 'IT flexibility' to enhance levels of strategic alignment — balance between different organizational dimensions [9,12–14] — under volatile circumstances [15]. Research demonstrates that this unique characteristic can facilitate constant adaptations and timely responses in terms of IT-based competitive actions geared toward sustained organizational advantage [1,16].

Although strategic management literature has evolved considerably during the last two decades, there seems to be a growing consensus over the fundamental attributes that characterize successful organizations [17]. The latest line of thinking argues on flexibility [16,18], adaptability of the organization in fast changing economies [19,20], and collaboration with business partners [21,22] as foundations of sustained competition. Although IT flexibility may to some extent strengthen an organization's armory of digital options [1,16] and accommodate frequent change [18], it is conceivable that this dimension in isolation may not be sufficient to drive sustainability and organization-wide innovation capabilities. The existence of strong collaborative capabilities has also been linked to increased levels of innovativeness while being strongly dependent on contingent factors [23,24]. In this respect, a collaboration capability reflects an organization's ability to organize and manage IT-enabled business relationships with internal and external business partners [25]. In a similar vein, it is also important to be able to respond to operational and market adjustments in a swift manner [15] and to take various external environmental factors into account [7,26]. Within this context, little attention has been paid to organizational innovativeness, IT-enabled business transformations, and the requirements to mitigate harmful value chain activities abound, that is, sustainable work practices under different environmental conditions and complexities [27•,28]. In that respect, networked organizations continuously need to

adapt to transformations, and co-evolve[3] and change with the business environment [29]. In doing so, they need to commit to 'Green IT' initiatives and sustainability transformation efforts by achieving societal goals within commercial goals, while simultaneously conserving, deploying, and efficaciously reusing organizational and IT resources in a responsible way [4••,27•].

To capture the complex interconnected and cross-boundary-spanning IS/IT upon which organizations, business networks, and societies heavily rely [30••], we now argue that a complexity paradigm approach is most appropriate. Against this background, this paper aims to understand how IT flexibility, collaboration with partners, and environmental business factors lead to enhanced sustainability-oriented innovation capabilities. We synthesize previous foundational peer-reviewed work and argue that: firstly, a theoretical perspective that emphasizes complex nonlinear relations between elements under continuous change allows us to better understand the interplay between an organization's IT capabilities, their collaboration potential, and environmental conditions under which organizations operate; and secondly, we opt for appropriate practical methodologies for rigorous and meaningful data analysis aimed at discovering complementarities between elements, and how they — as patterns — lead to specific outcomes [2]. This article begins by addressing the need for firms to develop their innovation capabilities and then proceeds to introduce complexity science as an appropriable theoretical lens. Following, we discuss three main ingredients that collectively — under certain conditions — increase an organization's sustainability-oriented innovation capabilities and deliver value to relevant stakeholders in the business ecosystem. The concluding section reflects on insights, presents conclusions, and discusses some avenues for future research.

Organizations' innovation capabilities

Innovation is a major concern for modern organizations [31,32] and organizations increasingly try to innovate the current marketplace using IS/IT [33]. Although many scholars have previously examined the productivity and business value of firm-level IT investments [34–36], there is still a lack of understanding how IT-enabled innovation is achieved, which key antecedents play a significant role, and under which conditions IS/IT drives the innovative capability of an organization. The innovation process has radically changed over the past two decades with the rise of new innovative technologies, Internet-of-things, cloud computing, strategic digital options, smart assets, and big data analytics, among other innovative enabling technology [37]. Organizations that optimally deploy and enable their assets, resources, and organizational IT capabilities are more innovative and effective, and more promptly respond to inherent changes in industry and market conditions than competitors [34]. A key takeaway from these important insights is that mutually reinforcing and complementary practices and competences lead to higher performance gains.

Most currently established classifications of innovation recognize the broad distinction between 'incremental' and 'radical' innovation. The former can be described as refinements of existing products, services, or technologies. These types of innovations are the most dominant form of innovation, especially in low-technology and medium-technology industries. Consequently, an incremental innovative capability is defined as 'an organization's ability to generate innovations that refine and reinforce existing products and services' [38]. The second type of innovation, radical innovations, includes fundamental changes to existing products, services, or technologies that often make prevailing products, services, and technologies obsolete. As such, radical innovations significantly impact the economic activity of firms competing in that market and are most prevalent in high and medium-high technology industries. Accordingly, a radical innovative capability is the capability of an organization to generate innovations that substantially transform existing products, services, and technologies [38]. In recent years, numerous studies have been published documenting the importance of innovation as a mechanism to address sustainability issues [39]. It is becoming increasingly more evident that innovations that promote sustainability and add social value are developed by extending organizational boundaries and collaborating with multiple entities. Paradigms such as open innovation [40], social innovation [41], value co-creation [42], and collaborative development [43] emphasize the need to go beyond local exploitation to expand the locus of reach and the richness of perspectives.

A complexity science lens that captures multi-way interactions

The science of complexity (sometimes referred to as complexity theory[4]) and complex adaptive systems (CAS) investigates complex and nonlinear relations between constituent entities under continuous change and includes studies on themes such as adaptation, coevolution, emergent system behavior, interactions between agents and entities, and decentralized control. It has a rich history and scientific roots in physics, mathematics, and evolutionary biology [44–49]. The science of complexity

[3] Adaptation and co-evolution are key attributes of complexity science. How complexity science specifically contributes to this review article will be addressed in the section 'A complexity science lens that captures multi-way interactions'.

[4] We use complexity science as the preferred term over complexity theory because complexity theory is also a branch within computer science and mathematics that deals with computational problems (e.g. P versus NP problems).