Making IS Relevant in a Connected World: Revisiting the Intellectual Structures Framework

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Abstract

The exponential growth of the Internet since the mid-1990s has greatly expanded the capacity of people everywhere to interconnect and engage through digital technologies. As a complex adaptive system of systems, the Internet has extended the range and complexity of phenomena of interest to Information Systems (IS) scholars. This is both an exciting opportunity and a challenge which we explore in this paper by revisiting the Intellectual Structures Framework (Hirshheim et al. 1996) which attempted to make sense of the fragmented adhocracy of IS, before the expansion and penetration of the Internet. We suggest that the IS adhocracy, with its multi-disciplinary and systems-oriented nature, gives IS researchers the requisite variety to contend with the increasingly diverse digital ecologies of IS-enabled human activities that have emerged in the ensuing two decades. Based on relevant research over these two decades we present a revised framework that (1) reflects the complexities of contemporary IS phenomena and (2) can act as an instrument for analysing such phenomena across a spectrum of human activities. We justify the form and content of the Revised Intellectual Structures Framework, providing examples of its application in IS research using appropriate research methods and techniques. We argue that our revisions to the original framework provides individuals, organisations, and societies with a conceptual lens that is necessary to better address the challenges and opportunities posed by the complexities of contemporary digital ecologies.

Keywords: Intellectual Structures Framework; Relevance of IS; Complexity; IS adhocracy

1 Introduction

"[The Internet is] the first thing that humanity has built that humanity doesn't understand, the largest experiment in anarchy that we have ever had."

Eric Schmidt, former CEO of Google

Internet usage statistics[1] show a major tipping point in the mid-1990s that heralded the Internet Era[2]. Over the ensuing two decades, the expansion of the World-Wide Web (the Web) has resulted in an extremely complex global environment of hyper-connections and mutual dependencies (Phister 2010). We have seen the rapid evolution of the static Web 1.0 into the interactive Web 2.0 (O'Reilly 2007) and then to the Internet of Things and the explosion of

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[1] https://en.wikipedia.org/wiki/Global_Internet_usage

[2] http://www.internetsociety.org/

social media platforms (Yoo 2010; Laghari and Niazi 2016). The combination of diverse digital technologies and the Internet has created ecologies of sociotechnical networks which have significant impact on human agency and have enabled a revolution in the range of activities in organisations (Huang and Sun 2016) and in society (Castells 2015; Rosenberg 2013). Moreover, digital ecologies have profound implications for Information Systems (IS) research and practice (e.g. Yoo et al 2010; Baskerville and Priess-Heje 2002) and, we believe, an urgent need to explore how to make sense of information systems that have emerged within these diverse digital ecologies (Ulieru 2010). We propose that the IS body of knowledge, accumulated over several decades, be leveraged to build evolutionary theories and methods that can support investigations of emergent dynamic phenomena from a multilevel perspective (McKelvy et al. 2015).

A relevant dictionary definition of the word ecology is "the set of relationships existing between any complex system and its surroundings or environment."[3] Our use of the term *digital ecology* is based on this definition and follows the recommendation of Kleineberg and Boguná (2015) who apply the term when taking an ecological perspective on the extremely complex interactions between multiple online social networks and their global environments in Web 2.0.

The emergence of complex digital ecologies has prompted the need to re-examine the nature of the IS discipline itself (Lee et al 2015; Walsham 2012; Winter and Butler 2011). This debate is driven by the need to accommodate the new phenomena emerging from the complexity inherent in these digital ecologies. Our position in this debate is that IS is a "fragmented adhocracy" because of its diversity, plurality, multi-disciplinarity and systems-orientation (Benbasat and Weber 1996; Benbasat and Zmud 2003). This argument was originally proposed by Banville and Landry (1989) and theorised by Hirshheim et al (1996) through social action theories. Hirshheim et al.'s (1996) contribution is a theoretically grounded framework, the original *Intellectual Structures* framework (Figure 1), which identified the variety of intellectual positions of IS. The framework identifies the domains that IS impacts and the orientation of changes in those domains. However, the original framework did not anticipate, and does not explicitly account for, the phenomena emerging from the complex sociotechnical digital ecologies, and in particular the wicked problems and non-equilibrium dynamic that characterises our digital worlds. Although the framework is not without its critics (see for example Walsham 1996; Mathiassen 1996) we believe this framework has the theoretical rigour to be expanded to address the challenges posed for contemporary IS by digital ecologies.

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[3] http://www.dictionary.com/browse/ecology

Domains	Orientations			
	Control		Sense-Making	Argumentation
	Instrumental	Strategic	Communicative	Discursive
Technology	Information Technology Systems			
Language	Formalized Symbol Manipulation Systems	Manipulative Communication Systems	Systems for Consensual Communication	Systems for Rational Argumentation
Organisation	Mechanistic Social Systems (ritualized tasks)	Political Systems (decision making hierarchy and control)	Cultural and Social Systems (negotiated meanings and practices)	Systems for Institutional Democracy (checks and balances)

Figure 1. IS Object System classes in the original Intellectual Structures Framework (adapted from Hirschheim et al. 1996). Note the three empty cells in the Technology domain

In this paper we examine how the complexity of digital ecologies has expanded the traditional focus of IS and how this has impacted on the nature of the IS discipline. Our objective is to articulate an IS construct that has the capacity and requisite variety to accommodate diverse digital ecologies and directly address the inherent complexity of these ecologies.

In pursuit of this objective we reinterpret and extend (Hirshheim et al.'s (1996) original *Intellectual Structures* framework. The paper draws on evidence for the increasing complexity of the IS environment and an historical assessment of the *intellectual structures* of IS. We argue for the extension of the Technology domain (see Figure 1) to address developments over the last decades but particularly the impact of social media and the Web. We also argue that the Language and Organisation domains of the framework need to be understood in terms of the dominant role of knowledge and the complex internal and external environments. Our interpretation of the domains of change, in the context of digital ecologies, results in six domains. We then show how each of these six domains has a range of different IS applications across the spectrum from ordered to complex phenomena. We demonstrate the implication and utility of the revised framework providing exemplar IS projects that can best be explained by integrating aspects from several domains related to the phenomenon. We conclude with a discussion on the implications of the new framework for IS theory and research methodology.

2   Background

As is widely understood, the Internet is a global technical structure of interconnected computer networks using standardized communication protocols. The technical complexity of the Internet as an *IT artefact* was recognised in the 1990s (Thompson et al 1997) and further established in the 2000s (Faratin et al. 2008). Our interest in the Internet is not as an IT artefact but as the infrastructure underpinning a network (i.e., the Web) of *IS artefacts*, which include technology artefacts, information artefacts and social artefacts (Lee et al 2015). Indeed, "the Web might be considered the world's largest information system providing a convenient framework for publishing and finding information on the Internet" (Stair and Reynolds 2013 p 26).

To support our claim of increasing complexity of IS in the Internet Era, we use four elements that together indicate that a phenomenon is complex (Hasan et al 2016). These are listed in the first column of Table 1 with well-known exemplar characteristics related to the Web in column 2.

The network of networks that is the Web provides a dynamic backbone for the complex interconnected world of systems ranging from micro-businesses, civil society organisations to multinational companies and interwoven with the many-to-many social connections of individuals everywhere. This digital environment exhibits traits of a complex adaptive system (Phister 2010). The Internet has changed space-time in ways that impact the affordances of information and communication technology (ICT), the information landscape and the boundaries that distinguish personal, business and social enterprise (see e.g. Schalow et al. 2013). These changes coincided with a focus on *knowledge*, as a driver of change through innovation (Boland and Tenkasi 1995; Nonaka 1994), and a growing understanding that complexity defines phenomena that are of interest to IS in the form of wicked problems (Newell et al 2000; Snowden 2002).

Complexity Indicator	Defining Web Characteristics
Multiple interacting elements: (adaptive systems with interdependent elements and feedback loops)	By definition the Web is an evolving network of interdependent networks with millions of interconnected nodes
Distributed control (with challenges of synthesizing the agendas of multiple stakeholders)	Tim Berners-Lee, founded and directs the World Wide Consortium (W3C) for the technical development of the Web. He also founded the Web Foundation to ensure that the Web serves Humanity without overall control by governments or other agencies.
Unpredictable dynamics and emergence: with the unpredictable effects of small changes in initial conditions.	The world of computes has defied predictions such as the famous 1943 quote of IBM Chairman Thomas Watson that "… there is a world market for maybe five computers." The Web is an emergent entity as are its components and applications for business and social use. These in turn have generated new e-business models and social movements.
Contradictory requirements which prohibit the setting of precise goals and measurable outcomes in the planning process	The Web has highlighted the tensions between its benefits and threats; between its inherent free and open nature and its inherent dangers of security and identity fraud. It has blurred the boundaries between the private and the public and redefine informational roles such as user, stakeholder or creator (Wagner et al. 2014).

Table 1 Assessing the web as complex against four indicators (adapted from Hasan et al 2016)

We suggest that most IS research deals with complicated systems that, while remarkable and may have many interesting facets, can be understood with methodical reductionist examination. However, we recognise that in the digital ecologies of the current IS landscape, there are problems of concern to IS scholars that are unpredictable, unstable and emergent. Many of these are complex socio-technical systems "comprised of populations of interacting entities where the overall system behaviour is not predefined but rather emerges through the interactions of its entities" (Kim and Kaplan 2006 p37). While there are still issues worth investigating that are complicated but not complex, there is growing interest by IS researchers

in accommodating complexity, where a non-reductionist approach may be adopted. This interest in complexity is evident in an emerging body of literature on IS and IS development as complex adaptive systems (Benbya and Kelvey 2006, Grover 2012, Kautz 2012, Vigden and Wang 2006).

The Web has effectively expanded the purview of IS to address the broad and diverse constituents of society that includes individual, collective (social and/or organisational) and societal levels, and most importantly the interactions between these different levels (Cecez-Kecmanovic and Jerram 2002). The Web has driven the development of a range of mobile, ubiquitous digital technologies whose success is grounded in access to (infinite) information, without concern for place or time (Vodanovich et al 2010). Such developments have also influenced the design and form of organisations and their underlying organising principles, highlighting their need to be flexible, adaptable and innovative in order to meet the constant and rapid changes in their environments, both internal and external (Besson and Rowe 2012). Concurrently, the Internet, and the technologies it has spawned, creates affordances that have driven the development of what is collectively termed social media that empowers individuals and collectives, both outside and inside organisational boundaries. For example, citizens now have the ability to rapidly mobilise and advocate against existing political power structures (Magro 2012) in ways that were not anticipated when the Internet was conceived (Rosenberg 2013).

3   Revisiting the Intellectual Structures of IS

Among the various debates about the nature of the IS and IS development (ISD) in the mid-1990s, the *Intellectual Structures* framework (Hirschheim et al 1996) depicted in Figure 1, provided a theoretical basis for, and insight into, the increased complexity and diversity to come. Rather than impose a unifying conceptual structure over the field such as Sidorova et al. (2008), these authors developed a 'federated' IS framework, based on social action theory. The framework is expressed as a matrix with one axis being domains of change, the areas that are changed by IS, and the other axis being the orientations that signify the purpose of the change brought about by IS. There are three fundamental orientations: control, sense-making (communicative) and argumentation (discursive); but a distinction is made between control over objects (instrumental) and humans (strategic). This distinction is important as instrumental control treats people as physical objects while the latter treats them as intelligent agents. The domains of change are technology (as artefacts), language (all forms of communication) and organisation. The cells of the framework represent object systems that, in an abstract way, show the diversity of IS in terms of their content and purpose as it was manifest at the time.

Critiques of the framework at the time questioned (1) whether the categorizations in the framework were representative of systems in the real world, or intellectual constructs that can usefully be compared to the real world (Walsham 1996), and (2) the limitations of the framework's focus on institution-based notion of ISD (Matheessen 1996). A more recent examination of the intellectual core of IS does not address the notion of IS as a fragmented adhocracy, but rather argues for a unified view of the discipline (Sidorova et al. 2008) that establishes the relationship of the IT artefact to activities at the individual, group, organisation and market. But this view makes no attempt to either explicitly or implicitly address the diversity and complexity that characterises digital ecologies. We suggest that shifting the emphasis from an IT artefact to the IS artefact (Lee et al. 2015), as mentioned previously,

highlights the need to address complexity. We believe this shift in emphasis is facilitated by the *Intellectual Structures* framework.

The typology of the *Intellectual Structures* framework is reminiscent of the modification of Giddens' original model of structuration theory, developed by Orlikowski (1992) amongst others, to have a profound influence on IS thinking (Jones and Karsten 2008). In the IS adaptation of structuration theory, technology-in-practice is both the medium and the outcome of human agency in mediation with facilities (such as technical artefacts), norms (organisations, communities and their variable cultures), and interpretive schemes (such as language/communications and all that is mediated by it). More recently, IS research has explored the entanglement of the social and material that compliments and extend structuration theory (Cecez-Kecmanovic et al. 2014; Scott and Orlikowski 2014). This interest in sociomateriality affords an explicitly theoretical perspective that encompasses complexity, connectivity and meaning that is congruent with digital ecologies.

However, we chose the *Intellectual Structures* framework because it reinforces the well-accepted and broad principles of structuration and social action as its theoretical base. This theoretical grounding provides a robust basis to amend these principles to meet the imperatives of the diversity and complexity of the Digital Age, particularly the unprecedented changes that have occurred following the global spread of the Internet and the transforming advances of the Web.

3.1   Reinterpreting the Technology Domain: tools to exploit the digital ecology

We have interpreted the Technology Domain as *tools* rather than *technology* (Kane and Fichman 2009) because "… the emergence of the Internet has made the digital tools necessary for innovation more affordable to a broad spectrum of previously excluded economic and innovative activity". (Yoo et al. 2010 p 726).

In the *Intellectual Structures* framework (Figure 1), the Technology domain is only populated by object classes in the Control orientation reflecting the organisational technologies of the time. Historically, IS discourse has been dominated by a perspective of technology that was restricted to organisational boundaries and where enterprise systems addressed the efficiencies to operations (Orlikowski 1992, Sidorova et al 2008). Enterprise systems have become almost ubiquitous and are now part of the basic organisational infrastructure that includes not only technical elements but also organisational data, information, operating procedures and support (Panetto and Cecil 2013). This infrastructure provides a stable foundation on which new IS applications are design and built through traditional ISD.

In contrast, the global infrastructure afforded by the Internet establishes a digital ecology on which a diverse set of IS and ICT tools are continually emerging (e.g. social media) and are used to support an increasingly diverse range of human activities. As well as these significant changes in technology, IS also needs to accommodate significant shifts in the business environments, which is itself driven by changing technology. The digital ecology affords radical new methods of communication, interaction, dissemination of knowledge and organising principles that were not possible previously (Hirschheim and Klein 2012). As a consequence, IS is now concerned with the evolution and appropriation of these tools, creating new activities that the tools afford and most importantly the promulgation of the tools from the individual, to groups, to organisations through to society (Klein and Hirschheim 2008). The significance of this development is that IS is not constrained by organisational boundaries.

Digital ecology raises a different set of issues, removing constraints on tasks or activities while supporting experiential learning, collaboration and mediating competition (Hirschheim and Klein 2012). The challenge now is how to exploit these tools and creatively leverage the affordances offered by each new generation of digital technologies while at the same time to understand the emergent impacts that digital tools, methods and applications will have on the way work is done and how we live in society. This has led to a plethora of new research streams within IS from new technical affordances enabling globalization, ubiquitous computing, crowd-sourcing, mobile applications, the cloud, social media and more. New settings for IS outside organisations in communities and social networks are blurring the traditional organisational boundaries (Walsham 2012; March and Niederman 2012).

However, this increased scope for IS has intensified the efforts of some scholars to unify IS, to define a bounded 'intellectual core' of the discipline and to capture new problems within existing frames in order to deal with complexity (Grover 2012). However, there is no general consensus on this endeavour (Sidorova et al. 2008). This highlights the paradox reflected in the question: "Why is discussion of crisis in the IS field so prevalent when the significance and usage of IS has grown dramatically?" (Westrup 2012 p 106). Our reinterpretation of the *Intellectual Structure* framework deals with this paradox.

As argued above, the Digital Age has brought generations of digital technologies to organisational, community and societal settings. Business, government and community organisations, other institutions, as well as individuals and civil society in general, continue to exploit and explore the digital ecology. We propose that changed realities and radical new technological affordances support Object Classes to populate all orientation of the Technology domain of the *Intellectual Structures* framework as shown in Figure 2.

Domains	Orientations			
	Control		Sense-Making	Argumentation
	Instrumental	Strategic	Communicative	Discursive
Digital Tools	IT systems, technology infrastructures	Information infrastructure to support: • Decision making, • Knowledge management, • Business Intelligence	Activities and communities in social media	Advocacy forums, e-democracy, Ethical Intelligence (AI, machine learning and algorithms)

Figure 2. Object Classes for all orientations of the technology domain in a contemporary reinterpretation of the Intellectual Structures Framework

Technologies. such as Intranets, KM Systems, big data, analytics and data driven decision making' provide Object classes for strategic decision-makers (Clarke 2016). The Object Classes proposed in the Strategic Control orientation of Figure 2 give organisational actors direct access to diverse data and analytic tools extend their strategic control capability within the organisational boundary.

More recently, applications associated with Web 2.0 and social media are impacting the Technology domain in the Sense-making orientation. Emergent phenomena developed in social settings, such as crowd sourcing (Feller et al 2012) and wiki knowledge repositories

(Pfaff and Hasan 2012), are crossing the boundary into corporations further blurring the organisational boundaries of the Technology domain. These social technologies are instrumental in the dynamic formation, evolution and transformation of social networks and are the basis of communities within, between and across organisations, institutions and civil society. Similarly, concepts such as the wisdom of (and in) the crowd (Surowiecki 2004) both within institutions, and between institutions and their constituencies, may be the basis of Object classes in the Argumentation orientation of the Technology domain. More recently we have seen an emergence into the mainstream of artificial intelligence (AI) agents and machine learning. Such technologies are often predicated on the ability to link and analyse multiple and diverse data sets to provide a coherent perspective on very complex societal phenomena (e.g. Strelioff et al. 2013). A particularly pertinent aspect of such "intelligence" is the current debates around human centred and ethical AI (Russell et al. 2015, d'Aquin 2018, Baum 2017).

To reflect the shift of emphasis from the technical artefact to the digital ecology, we have renamed the domain as *Digital Tools*. An important consequence of the expanded interpretation of the Technology domain as Digital Tools is that we need to consider the implications of the changes to the Technology domain for the Language and Organisation domains, as well as exploring its broader societal impact.

3.2   Language Domain: incorporating Knowledge and Change

In the original *Intellectual Structures* framework of Figure 1 we see Object Classes of the Language domain that reflect the ability of computer-based systems to not only crunch numbers and manage structured databases in the Instrumental Control orientation but also to manipulate free text, support communication, which at the time was predominantly email, and even allow some rational argumentation.

As noted above, the 1990s saw the emergence of a focus on knowledge within organisational and IS studies inspired by the seminal work of Grant (1996. 2002), Nonaka (1994) and others. The openness and expanding reach of the Web as well as the new interfaces, functionality and affordances of digital technologies enabled anyone connected to the Internet to access, generate and exchange content with the global community. Many researchers in IS felt that the term 'information' was no longer adequate to describe all that IS was about and began to talk of systems which dealt with 'knowledge'. This expanded purview of IS challenged the existing understanding of the Language domain.

In the field of knowledge management (KM), knowledge is viewed both as a thing (created, embodied and embedded) and as a flow (emergent and fluid) (Orlikowski 2002, Blackler 1995, Hasan and Crawford 2003, 2007). We recognise this distinction in *The Intellectual Structure* framework by transforming the Language domain into two domains. As shown in Figure 3, the *Information* domain is concerned not only with information but extends to knowledge creation and deployment as well as the more recent emphasis on "data". Information in this sense can be construed as a 'thing' that can be *mobilised* for building (organisational) capability. Such capability is necessary to make sense of complex digital ecologies and to act appropriately in response to this situational awareness.

The other domain is concerned with *Interaction* to emphasise the changing and fluid connections between individuals, entities and organisational constructs. Such connections are manifested in the knowledge and information flows that drive change through enhanced communication and learning (Senge 1990; 2014). The shift of emphasis from information to

knowledge also recognises the value of human and social capital (Wasko and Faraj 2005) and the role of learning, particularly to explore new ideas and builds the creative capacity for renewal through social learning and shared situation awareness (Warne et al 2003; Strati 2007). This is consistent with March's (1991) approach to organisational learning as a synthesis of exploitation and exploration. In this sense, Interaction is seen as 'flow', both as content that moves between actors and as an emergent and ever-changing link in a network of the ecosystem.

Digital ecologies provide the ability to engage across a far broader spectrum of activities, with more diverse actors, and span previously established boundaries, particularly the now porous organisational boundaries. Moreover, the Interaction domain broadens the purview of IS to civil society with scholars such as Winter and Butler (2010) advocating the responsibility of IS researcher to engage with other disciplines to tackle the grand challenges that face the global society.

Domains	Orientations			
	Control		Sense-Making	Argumentation
	Instrumental	Strategic	Communicative	Discursive
Interaction	Formalized Symbol Manipulation Systems	Information / records management	Wikis, co-creation of knowledge	e-democracy
Information	Communication Systems /email	Intranets	Blogs, chat Consensual Communication	Systems for Rational Argumentation

Figure 3. Object classes for orientations of information and interaction domains in an expanded reinterpretation of the language domain of the Intellectual Structures Framework.

3.3 Organisation Domain: the impact of complexity

In the original *Intellectual Structures* framework of Figure 1 the Object classes of the Organisation domain summarised across the orientations as social, political cultural and democratic systems. In the Internet Era, ways of organising have diversified, business models have changed, new organising principles have emerged, and whole new industries have been created. Organisations that were once understandable as systems are now seen as complex adaptive systems (Grover 2012; Kim and Kaplan 2006).

The increasing porous and fuzzy organisational boundaries, the Organisation domain needs to be interpreted as a verb rather than a noun; a domain that is concerned with organising rather than an organisation. This is a significant shift of emphasis as the term 'organisation' has generally been used in IS to indicated a physical, legal entity concerned with the production of goods and services. Digital ecologies have created affordances for diverse organisational forms and constructs. The increasing complexity of the process of organising (Crawford et al 2009) has led us to unpack the single Organisation domain of the *Intellectual Structures* framework into three domains namely *Structure, Action,* and *Relationships* as shown in Figure 4.

Organisational studies have traditionally been concerned with how organisations structure themselves, how they manage relationships in their coordinating mechanisms and how the division of labour relates to the way work is carried out (see e.g. Mintzberg 1979; Jones 2010). The growing complexity of the organisational context implies that these concerns are

interdependent. Never-the-less we suggest that their longstanding position of importance in the literature makes them ideal candidates for unpacking the Organisation domain of the *Intellectual Structures* framework.

The Structure domain emphasises the diversity and flexibility of the organising construct. Traditionally, organisational systems, such as enterprise resource planning (ERP), tend to support bureaucratic forms of organising, locking in existing structures and limiting flexibility and ability to change (Mohr 1971), especially when shifting from local to global operations (Crawford et al 2009). Digital ecology has enabled distributed, virtual and temporary organisational forms and expanded the range of viable structures from micro enterprises to multi-national networks of partnerships. But most importantly, the digital ecology has facilitated flexible organisational forms that enable dynamic transformation of structure to adapt to changes in context, whether this is regulatory, operational or socio-cultural. Significantly, digital ecologies also facilitate the co-existence of formal and informal (Ali 2011) structures that allow organisations to become ambidextrous (Agostini et al. 2017, O'Reilly & Tushman 2013).

Domains	Orientations			
	Control		Sense-Making	Argumentation
	Instrumental	Strategic	Communicative	Discursive
Structure	Bureaucracy	Matrix	Networked, self-directed	Self-organised Project-based
Actions	Mechanistic Social Systems (ritualized tasks)	Service dominant logic and new business models	Virtual teams	Ubiquitous socio-technical systems
Relationships	Command and Control	Decision making hierarchy and control	Cultural and Social Systems (negotiated meanings and practices)	Systems for Institutional Democracy

Figure 4: Object classes for orientations of new structure, relationships and action domains in an expanded reinterpretation of the organisation domain of the Intellectual Structures Framework

The Relationships domain highlights the significance of connections between actors to support diverse organising. The clear orientation of this domain is communicative. The emphasis in this domain is to support changing interactions between organisational actors by adopting flexible and scalable coordinating mechanisms (Adler et al 2011). Such mechanisms require a shared purpose, and an ethic of cooperation where collaboration is both valued and rewarded. One organizing principle that this domain encompasses is that organisations can cooperate and work together in parts of their business where they did not believe they had competitive advantage, while remaining fiercely competitive in other areas (Fisher 1992) as demonstrated in the extensive alliances in the airline industry.

Another illustration of the emphasis on the Relationships domain is relational contract theory (MacNeil 2000, 1980). This theory defines the behaviour of the actors involved in a transaction which is based on mutual trust, is enacted through collaboration (Campbell, Mulcahy & Wheeler, 2017) and expressed in norms that define the social relations that underpin the interactions. A very practical manifestation of such contracts is Performance Based Contracts

(PBC), especially for long term sustainment of defence equipment (Mouzas 2016, PBC CoE, 2014).

Underpinning the shift of emphasis of this domain is that the technological determinism is being undermined by innovative appropriation of digital ecologies, particularly by civil society and especially by marginalized groups and developing societies (see e.g., Steyn, 2007). Organisations now need to be alert to such innovations and be open to the possibilities represented by such innovations (Hanseth and Lyytinen 2010).

The Action domain deals with the organisation of work and the nature of work done, spanning the continuum from ritual tasks to independent, self-directed intellective tasks (Weick and Roberts 1993; Cornelissen and Kafouros 2008). Digital ecologies afford new ways of working and thinking, transforming work by supporting the continuum of routine prescribed procedures to flexible activities.

Traditionally, the focus of (organisational) work was on continuous improvement and optimization with the objective of making organisations (the noun) more efficient and effective (vom Brocke et al. 2011). Digital ecologies afford actions encompassing a range of tasks and activities encapsulated in the concept of knowledge work (Iivari and Linger 2000). Knowledge work integrates doing, the pragmatic task, with thinking, the cognitive task, and talking, the communicative task. These facets together influence how an instance of a work task will be performed. The knowledge work perspective is supported in Activity Theory where activity is the holistic unit of analysis of work and activity is the relationship between the subject (actor(s) engaged in the doing) and the object of work that encapsulates the purpose and motives of doing (Leontiev 1981). An activity both mediates, and is mediated by, the physical, virtual and psychological tools used (Hasan et al 2010). Digital ecologies provide the means to design, construct and execute activities that are flexible to reflect both the changing context and learning from performing the activity.

4   Illustrating the Domains

To illustrate our rethinking of the Intellectual Structures framework, we have selected a representative IS paper that highlights an aspect of the domains. Subsequently we present two examples of investigations of phenomena that provide a more holistic view of the application of our revised framework. Both examples concern situations where the increasing complexity of digitally-enabled sociotechnical systems affect traditional institutions: one is the military and the other local government.

What is evident from these illustrations is that the interpretations of the framework have also changed. Hirschheim et al (1996) presented their framework as a matrix of domains of change on one axis and the orientation of that change on the other axis. The cells of the resulting matrix were populated with object systems that represented archetypal IS. Their discussion of the fragmented adhocracy that the matrix represented implied that these were discrete systems. Their argument was that IS as a discipline was represented as the sum total of all the object systems.

The basis for our rethinking of the framework was the inherent complexity of the phenomena being addressed and the emergence of diverse digital ecologies. Together, these two factors are the basis for innovative systems, and the research that underlies such developments, that do not adhere to boundaries of the original framework. Digital ecologies raise affordances that

pluralise the impact of systems from individual, to group, to collectives (organisations) to societal levels (Upwood 2005). And these impacts are experienced simultaneously at all levels. But more importantly, the consequences of the impact at each level also influences the development of the IS artefact in other layers. It worth noting again the notion that the IS artefact includes technology artefacts, information artefacts and social artefacts (Lee et al 2015).

Our illustrations of the revised framework demonstrate that affordances of digital ecologies allow complex phenomena to be addressed in ways that span domains and orientations. Our contention remains that IS is a fragmented adhocracy. However, the IS artefact is itself more complex and spans space-time.

4.1 Domain examples from the literature

Domains of change	Comment
Digital Tools (Whitmore et al. 2015).	The Internet of Things (IoT) is a paradigm where everyday objects can be equipped with identifying, sensing, networking and processing capabilities that will allow them to communicate with one another and with other devices and services over the Internet to accomplish some objective. Ultimately, IoT devices will be ubiquitous, context-aware and will enable ambient intelligence. This article reports on the current state of research on the Internet of Things by examining the literature, identifying current trends and describing challenges that threaten IoT diffusion as a hybrid technical evolution. The paper demonstrates the pervasive nature of the digital ecology and its potential impact on all orientations not just the control orientation as in the original framework
Information (Pfaff and Hasan 2012)	Despite their reputation as an evolving shared knowledge repository, Wikis are often treated with suspicion in organisations for management, social and legal reasons. This paper reports a field study that was undertaken of a corporate Wiki developed to capture, and make available, organisational knowledge for a large manufacturing company as an initiative of their Knowledge Management program. A Q Methodology research approach was selected to uncover employees' subjective attitudes to the Wiki so that the firm could more fully exploit the potential of the Wiki as a ubiquitous tool for tacit knowledge management. Tensions were noted when employees struggled with the lack of structure in the Wiki and their responsibility to created structure as well as content in a more democratic organisational culture. The significance of this paper is that it highlights this domain is contested with the impact of change dependent on the perspective adopted. It also points to the paradigm shift required of all actors particularly in the communicative and discursive orientations.
Interaction (Melville 2010)	This study confronts the contribution of IS to countering the rapidly environmental degradation due to human activity. It takes the view that business enterprises are a dominant form of social organisation that contribute to the worsening, as well as the enhancement, of the natural environment. The paper describes the critical role that IS can play in shaping beliefs about the environment, in enabling and transforming sustainable practices in organisations, and in improving environmental and economic performance. An augmented belief-action-outcome framework and associated research agenda provide the basis for a new discourse on IS for environmental sustainability. This explicitly links social and organisational contexts regarding belief formation where individuals are conflicted between organisational values (eg short term profit motive) and personal values shaped by societal concerns (eg going green to save the planet). The paper emphasises the prominent role of the communicative and discursive orientations that are afforded by the digital ecology.
Structure (Sharma, et al. 2002).	The open source software (OSS) model is a fundamentally new and revolutionary way to develop software. Despite the success of OSS, for-profit organisations are having difficulty building a business model around the open source paradigm. This research explores how organisations can foster an environment similar to OSS to manage their software development efforts to reap its numerous advantages. Drawing on organisational theory, the research develops a framework that guides the creation and management of a hybrid-OSS community structures within an organisation. The paper highlights the socio-technical imperatives that underpin diverse organising principles afforded by the digital ecology

Domains of change	Comment
Relationships (Levy et al. 2003)	Co-opetition entails sharing knowledge that may be a key source of competitive advantage. Yet, the knowledge gained by cooperation may also be used for competition. This paper develops a game–theoretic framework for analysing inter-organisational knowledge sharing under co-opetition and proposes guidelines for the management of explicit knowledge predicated on coordination and control theory that remain untested. The research investigates these issues in the context of small and medium-sized enterprises. The paper points to the changing landscape, in an organisational context, of the engagement between actors that are possible in the digital ecology
Action (Vidgen and Wang 2009	This paper develops a framework for the organisation of agile software development that identifies enablers and inhibitors of agility and the emergent capabilities of agile teams. The work is grounded in complex adaptive systems and draws on three principles of coevolving systems: match co-evolutionary change rate, maximize self-organizing, and synchronize exploitation and exploration. These principles are used to study the processes of two software development teams, one using extreme programming and the other using a more traditional, waterfall-based development cycle. From these cases a framework for the organisation of agile software development is developed. Time pacing, self-management with discipline and routinization of exploration are among the agile enablers found in the cases studies while event pacing, centralized management, and lack of resources allocated to exploration are found to be inhibitors to agility. Emergent capabilities of agile teams that are identified from the research include coevolution of business value, sustainable working with rhythm, sharing and team learning, and collective mindfulness. The paper makes two important points; the need for a complexity perspective to understand the potential of digital ecologies and the need to do things differently in such a context in order to exploit the affordances of digital ecologies.

Table 2: IS papers that illustrate each domain within digital ecologies

4.2 Research example 1: team capability in the military

This project began with the development of Go*Team, an innovative online, team-gaming system based on the strategy board game GO[4]. The project expanded over four years into an action research program to investigate the use of Go*Team to develop the human capability for a network-centric configuration of collaborative teams in the complex military environment known as the "fog of war"[5]. The objectives for the project focused on team dynamics, situational awareness, information sharing, communication and trust, and timely and appropriate decision making under uncertainty.

Players of Go*Team belong to teams whose members can be anywhere on a computer network. Under researcher control, the protocols of play can be set to suit the circumstances of play. The most exciting capability of the Go*Team software is that it restricts what each player sees on their computer screen so no single team members can see the status of the whole board. Online forms of communication between team members during play are integral to the game as it enables team members to share status information as well as plan subsequent moves. Recordings of a game, together with audio recordings of team communications, provide data for the subsequent analysis and research.

Domain of Change	Comments
Digital Tools	Experiential learning tool simulating a network-centric configuration. Go*Team was designed to address the instrumental and strategic control orientation as well as the communicative orientation
Information	Information flows shifted from Command and Control hierarchy to more peer-to-peer information sharing for increased group situational awareness. The game included a variety of online communication that addressed the instrumental orientation and as this was networked, it also included strategic and communicative orientation. The game allowed team members to reason about the game which addressed the discursive orientation
Interaction,	Capability for a more innovative, flexible, agile organisation through networks of self-directed teams while adhering to game rules and rules of engagement. The design of the system and its operations (game playing) addressed all orientations
Structures	More self-organising networked configuration within the context of hierarchical structure. The game was explicitly designed to explore the network-centric paradigm. In this it explicitly addressed the communicative and discursive orientation.
Relationships	Encouraging informal collaboration in an intensive competitive game context. While the intent of the game was to encourage and develop a collaborative approach, game playing also showed that more traditional hierarchical approaches were also observed. This shows that all orientations are potentially addressed.
Actions	Game playing demonstrated the ability of team members to undertake ad hoc problem solving and independent decision making. This required players to understand and adapt to new ways of "doing things". This has a strategic orientation but explicitly addresses the communicative and discursive orientation.

*Table 3: An overview of the GO*Team games system*

Game playing demonstrated how well the Go*Team game embeds players in an environment that reflects the situation of network-centric teams where the transfer of information is needed

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[4] https://www.usgo.org/brief-history-go

[5] https://www.yourdictionary.com/fog-of-war

to enable shared situational awareness and sense-making leading to relevant decision-making and action. The research was designed to play games with a variety of participants and situations to investigate these phenomena.

This expanded the initial focus on the Tools domain to the domains of Structure, Information, Actions, Relationships and eventually interraction as shown in Table 3.

4.3   Research example 2: government-community engagement

The motivation for this action research project was new State government legislation required local municipal councils to expand their community engagement (CE) programs so that a wider range of citizens could participate in government processes. We were approached by a council's CE team to investigate how the council could use ICT to move beyond the current CE practice of traditional town-hall meetings.

The research investigated the tensions that arose between a bureaucratic organisation and a more open online system to engage citizens. The investigation began in 2011 with an intervention involving a workshop where the CE team would play the role of citizens in simulated online discussion on topics related to community needs and aspirations for the future. The workshop became a pilot for the use of such technologies for online CE. Based on feedback from the workshop, the Council implemented a proprietary online discussion forum which was evaluated over the subsequent seven years to ascertain how successful the Council had been in their use of ICT for CE and what impact, if any, has this had on the Council.

Domain of Change	Comments
Digital Tools	Web-based fill in form to a moderated discussion forum to social media. The Council relied on its existing IT infrastructure but addressed the strategic orientation by adapting it for online communication with citizens. Over the period of the project the CE approach addressed the communicative orientation but not the discursive as most communication was still pushed from the Council to citizens.
Information	Government to citizen information flow changing as citizens had the means to converse directly with Council. The CE project opened a variety of communications channels that addressed the both control orientations and at points also the communicative channel. However as throughout the project the Council still set the agenda, the discursive orientation was not addressed.
Interaction	Broader citizen participation in democracy. Although the intent of the Council's CE initiatives were ostensibly to implement e-democracy, our analysis suggested that the discursive orientation was not addressed.
Structures	Institutionalised bureaucracy. The CE project was grounded in the existing Council structures and did not move beyond the instrument orientation
Relationships	Tensions between government bureaucrats and the variety of citizens in different circumstances in the community according to different local issues. The tension was based on the Council retaining control over agendas and issues and the decision-making process. The emphasis on the control orientation meant that the affordances of online CE were only superficially enacted.
Actions	Corporate style management and community activism. While online CE suggests potentially new and empowering action, the reality of the project was that it was ritualised in terms of compliance with legislation and control over decision was maintained by the Council. Thus, the dominate orientation was control although it did open some aspects of the communicative orientation.

Table 4: An overview of online government-community engagement

This form of council led e-democracy represents a departure from the council management's "comfort zone" and created tensions. However, we do not argue that the reluctance to adopt e-democracy is simply a matter resistance to change. The dialectic challenge facing government is the need to deliver mandated efficiencies while also providing opportunities for civil society to be involved in decision making and co-production of services. Tensions between the openness of ICT driven CE and the everyday working of Council were evident in our findings. What was also apparent is that the real issue confronting Council was resolving the tension between their formal operational imperatives and the demands for informal citizen participation. In our study, a synthesis to resolve this contradiction has not been found.

5   Concluding remarks

We propose that the Revised Intellectual Structures Framework can be used as an analytical instrument to make sense of a complex phenomenon in a complex ecology without simplifying it or breaking it into separate components. We believe that it is often important to take this holistic approach. Indeed our conclusions, decisions and actions may be wrong if we don't.

This paper began by suggesting that the mid-1990s was a pivotal time in the impact of digital technologies on society just as the original Intellectual Structures Framework (Hirschheim et al 1996) was published. The subsequent evolution of digital ecologies made us re-evaluate this framework, extending its domains and incorporating more complex orientations

We chose the *Intellectual Structures* framework as our starting point because it reinforces the well-accepted and broad principles of structuration and social action as its theoretical base. As stated earlier, this theoretical grounding provides a robust basis for the amendments we have made to the original framework to meet the imperatives of the diversity and complexity of the Digital Age, following the global spread of the Internet and the transforming advances of the Web. Significant IS papers have been used to illustrate the application of each domain of the Revised Intellectual Structures Framework. Two examples of our own investigations of phenomena in complex ecologies have provided a holistic view of the application of our revised framework.

We propose the resulting Revised Intellectual Structures Framework as a research tool that

- is holistic and appropriate for the study of complex ecologies

- incorporates and expands the original framework into six domains based on the changed digital ecology in which IS now exists

- captures the level of complexity within each domain of change

- is able to underpin non-reductionist IS research into real-world issues

- recognises that the complexity of phenomena under study usually spans more than one cell of the matrix of the framework and any development in one cell needs to be conducted in the context of other cells.

- enables research which is reductionist to posit their results in a wider context.

- has implications for scope, methodology, theory and epistemology in IS

The Revised Intellectual Structures Framework supports the current trends for organisations to be ambidextrous (O'Reilly and Tushman, 2013; Raisch et al 2009) accommodating formal structures and informal networks. This elevates decentralized decision-making, self-directed

and informal groups in network-centric arrangements where actors are empowered by giving them the authority and skills to self-organize. These trends allow innovative organising forms that exploit (and explore) the digital ecologies. These trends are not simply an appropriation of the informal into the formal structures but simply acknowledging the existence of the informal, ceding legitimate authority to those forms and working on the mechanisms for dynamic co-existence to meet the emergent needs of each situation.

The Revised Intellectual Structure Framework has implications for IS research in respect of the scope, methodology and in particular the ability to address complex phenomena. Simplifying complicated problems can improve our understanding and lead to viable solutions. However, simplifying a complex problem can often make it wrong in the sense that solutions to the simplified problem do not work for the original complex problem (Gray 2009). In attempting to be scientific, IS scholars have avoided or limited the scope of their investigation of complex phenomena despite calls to conduct research that really matters (Desouza et al. 2006); addresses wicked problems (Kazlauskas and Hasan, 2009); engage with grand challenges, (Eymann et al 2015; Winter and Butler 2011; vom Brocker et al. 2015) and especially issues associated with the fifteen global challenges identified by the United Nations Millennium Project (UN 2015; Lee 2015). Articulating and investigating the role of IS in large-scale, complex problems can involve the adoption of difficult strategies and choice of controversial research methods and approaches (Winter and Butler 2011).

The Revised Intellectual Structure Framework is an attempt to provide an instrument for facing these challenges in the following ways.

- It broadens the scope of acceptable problems to be investigated by IS researchers into realms of complex and wicked problems. When a phenomenon of interest has a large number of interacting variables, the acceptable empirical approach is to reduce the number of variables investigated and to bound the topic to make it manageable according to scientific, mode 1, approaches (Gibbons et al 1994). Some IS researchers are moving outside these constraints, for example those who are beginning to look at IS development as complex adaptive systems (e.g. Kautz 2012, Benbya and McKelvey, 2006).

- It guides projects that address many interacting aspects of wicked problems. Such holistic projects could potentially include phenomena covering all six domains of the framework including dynamic and diverse perspective of the relationship in these domains.

- Where research is focused on a single perspective of one domain of the framework, its bounded context can be acknowledged, but the implications of the research for domains and orientations not addressed can be discussed. In this way the research is focussed but does not lose a holistic perspective.

- Methodological consequences of research that addresses complex phenomena includes innovative research approaches to cross boundaries and incorporate elements of complexity alongside more traditionally scientific methods.

- Some IS scholars are already exploring theories and methods suitable for the study of complex phenomena (see for example Ketter et al. 2016 Schmitz et sl. 2016). The revised framework provides a context to situate such approaches within the fragmented adhocracy of IS

The contribution of this paper is an extended framework that makes sense of the fragmented adhocracy of IS in the context of complexity and diverse digital ecologies. Its authenticity comes from its grounding in the original insightful Intellectual Structures framework (Hirschheim et al's 1996) but takes into account developments in ICT, the internet and digital ecologies. These developments underpin our reinterpretation of the domains of change in order to explicitly broaden the scope of IS and enable us to populate the cells of the matrix of the framework with object systems that are aligned with the affordances of diverse digital ecologies. Moreover, the revised framework also reinterprets IS not as a discreet artefact that populates a particular domain and orientation (a cell in the matrix) but as a socio-technical artefact with many facets that span the matrix in a variety of ways.

We present Revised Intellectual Structures Framework as the basis for a theory of explanation which "… provides an explanation of how, why, and when things happened, relying on varying views of causality and methods for argumentation" (Gregor 206 p 619). What is more, the Revised Intellectual Structures Framework is an instrument for making sense of problems that are messy, complex, chaotic and wicked. It does not simplify complex situations, as we have already noted the folly of this approach, but it plays a vital role in making IS more relevant in diverse social, institutional, organisational and digital ecologies.

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