A CONCEPTUALIZATION OF COMPLEXITY IN IS-DRIVEN ORGANIZATIONAL TRANSFORMATIONS

Research-in-Progress

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Abstract

Organizational transformations reliant on successful ICT system developments (continue to) fail to deliver projected benefits even when contemporary governance models are applied rigorously. Modifications to traditional program, project and systems development management methods have produced little material improvement to successful transformation as they are unable to routinely address the complexity and uncertainty of dynamic alignment of IS investments and innovation. Complexity theory provides insight into why this phenomenon occurs and is used to develop a conceptualization of complexity in IS-driven organizational transformations.

This research-in-progress aims to identify complexity formulations relevant to organizational transformation. Political/power based influences, interrelated business rules, socio-technical innovation, impacts on stakeholders and emergent behaviors are commonly considered as characterizing complexity while the proposed conceptualization accommodates these as connectivity, irreducibility, entropy and/or information gain in hierarchically approximation and scaling, number of states in a finite automata and/or dimension of attractor, and information and/or variety.

Keywords: Complexity theory, Information system complexity, Organizational Transformation
Introduction

Organizations respond to changing competitive contexts using new information systems (IS) to improve efficiency and/or maintain competitive advantage (Merali et al. 2012). However, disappointing failure rates continue to waste significant resources (Doherty et al. 2012). Scrapping the £12 billion project to provide electronic health records for UK citizens and extra costs of $1.25 billion to fix the payroll system in Queensland Health are well publicized recent failures. The expected benefits identified in approved proposals are often not delivered even though a technical build may have succeeded (Binney et al. 2007). Hence, this research-in-progress investigates possible factors contributing to these failures including limitations of conventional development methodologies and complexity of the transformations.

Many studies, from as early as the 1960s have been directed at project failure phenomena (Bartis et al. 2008). They have identified a variety of failure factors without consistent definition or evidential causality of complexity (Baker 2012; Doherty et al. 2012; Kotter 2007; McManus et al. 2008; Whittaker 1999). Yet many case studies exiguously allocate some portion of blame to complexity of the project (Courtney et al. 2008). These studies fail to provide insight into why potential failures are not identified early in the process (probably due to the low probability of failure of separate components (Amaral et al. 2007)) and why problems appear to escalate in an exponential manner (butterfly effect (Gleick 1997)). Little research exists to link failure to deliver benefits and complexity theory (Courtney et al. 2008) and without an agreed and consistent conception of complexity in IS-driven organizational transformations, it is not possible to gauge its impact. Although the broad aim of this research is to determine the impact of complexity on IS-driven organizational transformations a precondition requires conceptualization of complexity in this context and is the focus of this research-in-progress paper.

This paper will detail the conceptualization of complexity in an IS-driven organizational transformation context. The following sections will restate the purpose of this paper; clarify the organizational context under investigation; annotate a range of literature on complexity and aggregate these into a conceptualization of complexity relating to IS-driven organizational transformation; and lastly reflect on the significance and limitations of the study.

Purpose

“Advances in theoretical science have often been based on finding useful compact descriptions of a phenomenon of interest.” (Kauffman 1995)

The aim of this research-in-progress paper is to develop a conceptualization of complexity as it applies to IS-driven organizational transformation systems development. The conceptualization must reduce ambiguity, have minimal parameters for contextual modification (Edmonds 2004), and be somewhat abstract to support evolution to even better formulation (Allen et al. 2006). It will be both prescriptive (reflect the goals of the transformation) and descriptive (able to provide insight to a variety of contexts) (Edmonds 1999). This paper will develop a conceptualization of complexity in transformative systems (IS-driven), using existing theories and cases drawn from the AIS scholars’ basket of journals as the exploratory basis for the investigation.

Organizational Context

This investigation proposes a gestalt approach to the role of IS in transformational change where initiatives aim to maximize the benefits realized from investment and to cost-effectively contribute to organizational goals (Bradley 2010). The environment of modern organizations is increasingly complex and uncertain (Merali et al. 2006), and that their response to this dynamism almost always depends on changes in information systems, organizational structure and corporate culture (Safrudin et al. 2012). Although moderate strategic effort is directed at benefit definition in these transformations, the incidence of systemic assessment of benefits delivered is low so in many cases sponsors are unaware of whether new business and IS structures align with the business strategy and whether any competitive advantage has been achieved (Ashurst et al. 2008). Post-project evaluation of governance provides evidence of this alignment (Apfel et al. 2007).
Contemporary governance approaches may not be effective in directing transformative initiatives since there is a lack of material improvement in success rates as the approaches are applied more rigorously (Ward 2007). This may be due to the equivocality of the term (governance) with associated misunderstandings leading to unclear definition of accountabilities (Jessop 2003). It may also reflect the competence or self-interest of business strategists. Inflated benefit projections in initial proposals, claimed to ensure project approval, create unachievable expectations (Jenner 2010a). Yet business case development and feasibility analysis are mature practices which follow linear paths, based on rules and standardized practices. Although complicated, these tasks do not display the characteristics of complexity (Edmonds 1999; Snowden 2007) so are unlikely be the sole cause of this consistent pattern of failure. Failure to achieve expected outcomes is considered more sinister by Flyvbjerg et al. (2012). He claims many benefits are overstated for the purpose of approvals due to either incompetence or intentional misrepresentation. As transformation activities become more complicated, the impact of bias and overconfidence also increases (Jenner 2010b). However, these inconsistencies are identifiable before authorization by conventional reporting regimes (time, cost, quality) since they are common and focus on formative evaluation (Beynon-Davies et al. 2004). Issues likely to impact on project outcome are often neither formally reported for political reasons nor discussed by the project board (McManus et al. 2008). These power games cause dysfunctional systems to be erroneously reported as successful (Bartis et al. 2008; Jessop 2003). Given the problems with predictors of success at formative stages of transformations, traditional reports are unlikely to identify the contextual and mutually constitutive nature of systems and overlook the emerging organizational phenomena that drive projects in unanticipated directions (Kim et al. 2006).

Both anecdotal (McIntosh 2012) and research data (Hanseth et al. 2010; McBride 2005) indicates complexity plays a role in outcomes of IS-driven organizational transformations (Allen et al. 2006). Reliance on development methodologies, with governance models based primarily on time, cost and quality, and without consideration of strategies to recognize and respond to complexity, may result in systems which do not meet expectations of sponsors (McManus et al. 2008). Dombkins (2008) advocates the development of non-traditional project management capabilities to address complex scenarios and recognizes characteristics such as uncertainty, change and chaos exist in complex developments. However, his categorization framework fails to address the characteristic of emergence where the behavior of the system cannot be simply inferred from the behavior of its components (Kiely et al. 2005; Whitty et al. 2009). It is commonly agreed the problem relates to the number of components, their interrelationships and the ability to design, build and implement a system that accounts for nuances of these components and their linkages (Merali 2006). Therefore some novel approach is required which is less concerned with measuring tangible outputs and more concerned with process, emergence and impact (Hughes et al. 2013). It must incorporate complexity, reflect environmental contexts, provide direction on strategies, and articulate holistic progress of both planned (expected) and indirect (not planned) benefits throughout the development lifecycle (Esteves 2009; Harris et al. 2008). Mencken provides a hint of why systems fail in his humorous quote "For every complex problem there is an answer that is simple, neat and wrong." (MacLeod 2005). Consequently, this research requires a sound theoretical basis and the need for a conceptualization of complexity in IS-driven organizational transformations.

**Complexity**

In order to deliver a substantial improvement in transformation success, the focus requires a paradigm shift to understand the contribution of complexity to project outcomes (Amaral et al. 2007; Courtney et al. 2008). Complexity theory has been used in the fields of physics, biology, mathematics, ecology (Hughes et al. 2013) and may assist in modeling IS-driven organizational transformation systems in the same way a model of highly fluctuating financial markets has been developed to forecast dynamic financial (complex) behavior (Castillo et al. 2002). However, the term “complex” is inconsistently applied in IS-system case studies (Wise et al. 1993). Meanings include: difficult to do (but solvable by application of some unspecified effort/strategy); large in scope and functionality (but reducible and able to be solved by solution of the decomposed sub-problems); ambiguous and uncertain (resolved through clarification strategies); and unknown sets of unknowns (unable to be solved using pre-defined solution algorithms). Without an agreed and consistent definition of complexity, it is not possible to gauge its impact on systems transformation. To ensure clarity, this project identifies a complex system as one falling into the
category of “unknown unknowns” (Pich et al. 2002), where a number of interacting influences (some of which may not be identifiable from the outset) prevent development of an optimal solution (Edmonds 1999). Complex systems are made up of a number of components whose interrelationships have the ability to cause unexpected outcomes, which are neither predicted nor predictable based on historic behavior (Boisot 2006; Cotsaftis 2009).

Complex, high risk projects involve multiple dimensions each with challenging measurement ranges, and contributing to overall inherent risk of the project (Taylor et al. 2012). Complexity factors \textit{internal/external visibility, external project/process dependencies, technology uncertainty, and stakeholder involvement} are specifically nominated but are also implicated in other risk factors of \textit{criticality} and \textit{size}. These correlate well with the frequency of reference to complexity factors \textit{(political/power based influences, interrelated business rules, socio-technical innovation, and impacts on stakeholders)} identified in a subsequent review of contemporary IS research publications. Consequently, in order to understand the fundamental properties of complexity and its contribution to project success, a subset of the dimensions will be subject to deeper analysis. The development of a model incorporating only a subset of all possible contributing components seems to do an injustice to the concept of complexity, but an exploratory model (to increase understanding of how a system behaves, rather than trying to explicitly model any particular organization (Canessa et al. 2006)) may be simple in the way that mass and length are sufficient to describe the motion of a simple pendulum (Kauffman 1995; Stevens et al. 1998). This approach may suffer from the errors of inclusion and exclusion required for robust IS scholarship (Benbasat et al. 2003). However, although few models definitively describe their target phenomenon, they are often still useful (Mitchell 2009). Hence, some of these dimensions of complexity are no doubt more important as contributors to IS-driven organizational transformation success while the impact of others may be negligible.

Complexity theory is an amalgam of approaches undertaken in a range of research centers and broadly incorporates one or more of complex adaptive systems (CAS); far-from-equilibrium conditions; autopoiesis; chaos theory; increasing returns and path dependence; systems theory; cybernetics; and social network theory (Mitleton-Kelly et al. 2004). Three similar dimensions of “system implementation” complexity exist comprising (1) variety (the multiplicity of project elements), (2) variability (changes in project elements such as scope), and (3) integration (degree of coordination between project elements) (Ribbers et al. 2002). A deeper understanding of some of the dimensions will provide a better basis for later research than a superficial recognition of all components since: (a) all dimensions may not be able to be identified in any case; and (b) the key issue is not about the degree of incompleteness of the proposed model, but rather the opportunity to progress the model through further research (Hanseth et al. 2010).

It is anticipated that complexity theory will assist in the identification of the most applicable dimensions (such as emergence and non-deterministic behavior) to provide “\textit{contingent insights that will mean a difference}” (Leleur 2008). A probe-sense-respond approach to pattern entrainment provides the capability to move from complexity to order (Kurtz et al. 2003), and the new organization must address changing cultural, social, organizational, technical and political conditions (Mitleton-Kelly 2005). However, the degree of non-linearity in IS-driven organizational transformations introduces randomness that diminishes the ability to robustly predict the outcome (Merali 2006). The large number of existing formulations of complexity (48 documented in 1990) suggests the need for a common explanatory framework (Edmonds 1999). If all the contributing components (those things that make it complex) are to be incorporated, the epistemological problem to be addressed would be too great to be attempted (Allen et al. 2006). Also, the construction of agent-based models incorporating social systems is a challenging prospect (Courtney et al. 2008). Hence, the existence of core set of phenomena is assumed and will be incorporated into a germinal model. To attempt otherwise would stagnate framework building in this domain through the inability to progress with absolute confidence. It would reinforce the notion that, due to differing dimensions of every complexity component contributing disproportionately to success of IS-driven organizational transformations, progress towards both a model of complexity and approaches to success in IS-driven organizational transformations would be obdurate.

\textbf{Design Approach}

Although the genesis of this research lies in the number of failures of highly visible projects, it is more concerned with providing insight throughout the life-cycle of any IS-driven organizational transformation.
The variety of options for decisions, processes, structures and technology interventions (and through transitions, typically moving into conditions of greater complexity) ensures a system subject to transformation is in constant nonequilibrium (Courtney et al. 2008; Hanseth et al. 2010). By the theory of computation, the predictability of an outcome from such a system in a finite time can only be determined by watching it in real time (Kauffman 1995). This is fine if it is successful and one plans to replicate the project in all material ways (requirements, stakeholders and so on) and hence provides a deterministic algorithm able to be repeated (Kurtz et al. 2007; Stevens et al. 1998). So, for a system successfully implemented in a particular environment, it should be able to be replicated across any other equivalent environment. This is a popular and successful IT development strategy where pilots are tested before broad implementation (Wysocki 2011). However, it is unlikely that two IS-driven organizational transformations are equivalent with the associated inability to replicate them in different environments (Flyvbjerg et al. 2012). Hence, a reliable conceptualization must have minimal parameters for contextual modification (Edmonds 2004), and be somewhat abstract to allow existing parameters to be tested/superseded and support evolution to even better formulation (Allen et al. 2006). Complex adaptive systems (CAS) accommodate these constructs since they incorporate both ambidexterity and punctuated equilibrium (Merali et al. 2012) and provide an opportunity to expand the theoretical and methodological scope of IS research (Nan 2011).

**Complex Adaptive Systems**

Transformations are CAS since they are socially constructed entities (Canessa et al. 2006; Whitty et al. 2009). CAS behavior reflects the adaptive strategies of individual agents giving rise to emergent phenomena collectively termed self-organization. Adaptive agents interpreting information (non-uniquely) and absorbing it into self-organizing processes explains why conventional planning and control methods fail in complex environments (Hughes et al. 2013). Also, from systems theory, agent activity and organizational responses are difficult to isolate due to effects of feedback where positive feedback continues/accelerates the current trajectory and negative feedback may be able to moderate/halt it (Meadows 1999). Adaptation, typically modeled as the state-space of possible outcomes with a central concern being how to find optimum states, is extended by Kauffman (1995) to address co-evolution using fitness landscapes of multiple non-overlapping patches, where sets of patches are interconnected and each patch is allowed to adapt for selfish advantage. A complex adaptive system consists of a number of agents (not necessarily human), using sets of rules called schemas to determine the behavior of both agents and the complex system (Stacey 1996). Hence, the effectiveness of CAS to inform modeling of organizational behaviors in complex transformations is determined by the selection of appropriate parameters (Anderson et al. 2003).

**Complexity Parameters from Theory and Cases**

Analysis of a sample of contemporary publications provided a potential set of parameters able to be used to contextualize conceptualization of complexity in IS-driven organizational transformations. The cases reviewed were selected from the AIS scholars’ basket of journals since this provides a source of topical, methodological and geographically diverse research articles in the IS field (Senior Scholar Consortium 2011). The Web of Science database was searched for “complex” AND “case” in the publications nominated by the AIS for the period January 2007 to February 2013. The search returned 47 articles from which 17 articles were relevant to this study. The majority of the articles eliminated used complexity in its colloquial form, without strict definition and being a general term for an activity that may be difficult, unclear, new, or some other non-trivial meaning (Wise et al. 1993). Cases were selected from the following journals: *European Journal of Information Systems; Information Systems Journal, Information Systems Research, Journal of Information Technology, Journal of Strategic Information Systems, and MIS Quarterly.*
Descriptors based on the Cynefin Framework (Snowden 2007) were used to provide a context for the analysis of the journals. The following descriptors were used to codify identifiable attributes:

a) Observable – or simple “known knowns”;
b) Discoverable – or complicated “known unknowns”;
c) Unpredictable - or complex “unknown unknowns”.

The categories, developed from the attributes of the project risk assessment process, (Taylor et al. 2012) were subdivided based on the descriptors above. Chaos contexts were not coded as this did not appear as an identifiable attribute.

References to complexity in the 17 case studies were coded and later grouped to reflect emerging themes of that attribute. For each of these categories, further sub-categories emerged. Despite having a limited number of case studies, these sub-categories provided insights on how complexity is described in case studies of transformation activities and were limited to: Political/power based influences, Interrelated business rules, Socio-technical innovation, Impacts on stakeholders (including Δ culture), and Emergent behaviors.

The analysis of the scholar’s basket of journals supports the findings of the wider literature review that the organizational context (project landscape of Wysocki (2011)) must be understood in order to perform successful transformative activity. However, it is also clear that an empirical approach is not used to describe the fundamental details, the systematic reasons for the emergent behaviors in complex transformations or provide robust guidance to practitioners.

A numeric quantification of complexity has been attempted and succeeded to some degree and applied to a broad church of complexity interests including biology, physics, computation, economics and some aspects of formal languages (Edmonds 1999). However, this research-in-progress is not concerned with the relative complexity of one system compared to another, rather that once complexity is identified in an organizational transformation, some impact is able to be associated with the proposed (non)interventions. Some of the formulations of complexity used as a basis for the “complexity measures” are however relevant to the development of a CAS model for organizational transformation complexity. To be of value to the CAS model, the complexity formulations must in some way contribute to one or more of the following (Hughes et al. 2013):

- Interconnectedness – not only between elements, but between systems
- Emergence – global behavior arising from local interactions, but unable to be traced back to individual parts
- Adaptive Agents – agents capable of change due to considered, but not necessarily intelligent choices
- Self-organization – emergence of patterns of behavior across systems due to interconnectedness of agents
- Feedback and Path Dependency – both positive and negative feedback with capability to influence system behavior
- Initial Conditions – state of the system at any particular time where small changes may lead to large non-linear effects.
- Non-linearity – multiple and mutual interdependence cannot be identified as cause and effect pattern
- Strange Attractors, Chaos and Edge of Chaos – behavior of systems within certain boundaries which although unable to be explained deterministically, statistical approaches may provide meaning.

Complexity formulations considered relevant to IS-driven organizational transformations (but not expanded due to limitations of space) are summarized in Table 1.

It is now prudent to revisit the motivation for this research-in-progress in order to give meaning to the abundance of aggregated information on complexity. A mechanism is required to determine whether or not a particular transformation is considered complex. The tool proposed is a conceptualization of
complexity based on existing theory and frameworks and reflective of the stage of the transformation life cycle. Some of the formulations will materialize during the planning/design phase(s), while others will be predominant during implementation. This arbitrary segmentation is proposed simply to place some structure on the conceptualization below to facilitate its application in the subsequent case analysis.

<table>
<thead>
<tr>
<th>Formulation</th>
<th>Relevance</th>
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<tbody>
<tr>
<td>Connectivity</td>
<td>Due to the extent of inter-connections between components of a system, it is difficult to decompose the system without changing its behavior. Equivalent to organized complexity represented by a sizeable number of interrelated factors which synergize to an organic whole (Mitleton-Kelly 2005; Snodgrass 2011).</td>
</tr>
<tr>
<td>Dimension of Attractor</td>
<td>Chaos concepts are firmly grounded in the deterministic world of physical sciences (not complex by Snowden definition (Kurtz et al. 2003)) but edge of chaos region provides the best opportunity for transformative change (McBride 2005).</td>
</tr>
<tr>
<td>Entropy</td>
<td>A measure of the level of disorder - greater disorder requires more information to describe it precisely. Equivalent to disorganized complexity represented by many independent variables (modeled with statistical techniques) (Snodgrass 2011).</td>
</tr>
<tr>
<td>Goodman’s Complexity</td>
<td>When confronted by two theories apparently equal on experimental evidence, accept the simpler one – the complexity of a complex statement is the sum of the complexities of its components.</td>
</tr>
<tr>
<td>Information</td>
<td>The amount of information a system encodes or needed to describe a system – may include patterns which become indistinguishable from random patterns at high complexity.</td>
</tr>
<tr>
<td>Information Gain in Hierarchically Approximation and Scaling</td>
<td>Chaotic physical artifacts, fractal by nature, with different behaviors at different levels of granularity.</td>
</tr>
<tr>
<td>Irreducibility</td>
<td>Inability to decompose hierarchically without losing synergy of interrelationships - applies to modeling organizations; and as a result of self-organization</td>
</tr>
<tr>
<td>Number of States in a Finite Automata</td>
<td>Complexity as the number of states in finite automata has been widely applied to characterize emergent behavior in economic game theory, social structure and in chaotic systems.</td>
</tr>
<tr>
<td>Variety</td>
<td>Variety is an indication of complexity and is characterized by diversity of components, multidimensionality and the presence of sudden changes (Mitleton-Kelly 2005). Applications include: punctuated behavior; competing behaviors and control.</td>
</tr>
</tbody>
</table>

**Conceptualization of complexity in IS-driven organizational transformations**

Using Table 1 and the outputs from the study of the AIS scholars’ basket of journals as a basis, the conceptualization:

a) Indicates the presence of complexity, but does not apply a measure or relative weight to its existence;

b) Will be used as a forensic tool post-implementation in an attempt to describe the complex phenomena experienced.
During design, planning, the following may have been experienced:

a) Connectivity – sub-systems may be coupled so tightly that they are unable to be completely defined independently (e.g. tightly congested dependency mapping and/or high proportion of interrelated business rules);

b) Irreducibility – difficult to logically decompose the transformative environment in order to provide a comprehensive model of the new environment (e.g. unable to develop a strategy to identify initial conditions with sufficient precision and models advising best branches of the implementation tree options);

c) Information and/or Variety – unable to incorporate all of the required functionality in order to provide a comprehensive model of the new environment (e.g. conflicts between powerbrokers wanting to protect their field of influence)

During implementation:

a) Number of States in a Finite Automata and/or Dimension of Attractor – pre-planned activities do not produce the anticipated outcomes and are unexpected (not the result of incompetence or error) (e.g. stakeholder response to the initiative suddenly escalates/changes from support to attack);

b) Entropy and/or Information Gain in Hierarchically Approximation and Scaling – outbreaks of chaotic behavior which when investigated reveal well defined patterns which were not evident, but existed all the same, at a macro level (e.g. sophisticated undermining of the transformation by strategic release/withholding of critical information)

Outliers:

a) Dimension of Attractor – able to be used as a lever for transformational change if adequately managed (e.g. demonstrations of blueprints or prototypes to provide a focus of the new environment);

b) Goodman’s Complexity – able to be used to assist in decision-making when complexity creates difficult situations (e.g. when exposed to an unknown situation, use trial and error – but keep it simple as per the formulation)

Research Methodology

This research-in-progress is a microcosm of the broader research project. The epistemology that informs it is constructivism. Constructivism, with its emphasis in objects tandem with the observer’s experience (Allen et al. 2006; Von Glasersfeld 1984), allows for re-definition of existing knowledge (facts, information, descriptions, or skills acquired through experience or education) and truth (in accord with fact or reality, or fidelity to an original or to a standard or ideal) that form a new paradigm (a pattern or model, an exemplar) (Hutchinson 2012). In the broader study, a challenge is issued to the applicability of the range of frameworks used in contemporary IS-driven organizational transformations since modeling is an accepted research tool for complex systems (Kiely et al. 2005; Merali et al. 2006). Configuration theory accommodates interconnectedness of multiple subsystems, the organization and the environment (El Sawy et al. 2010), while enabling human actors to attribute meaning through linking their perceptions together to form a viable whole (Checkland et al. 1997). The implication from constructivist epistemology is that an opportunity for a philosophical paradigm shift exists where complexity introduces conceptually new experiences in IS-driven organizational transformations.

A qualitative research approach is proposed since it provides the opportunity to “flesh out what is really happening” (Weingand 1993). The research design ensures the research is relevant to both academics and industry, is project driven and not limited to a specific organizational domain (Wiewiora 2011). Four case studies will be subsequently analyzed to build meaning, integrate prior experiences and construct ideas, consider the dialectic nature of the researcher-case relationship and to extrapolate to a broader environment (Packer et al. 2000; Tsai 2000). Patterns of behavior will be identifiable as they emerge across the cases (Merali et al. 2012). The conceptualization of complexity in IS-driven organizational transformations will be applied to existing artifacts and interviews of key stakeholders. A pilot case study will be used to develop and test protocols, one to complete the exploratory component (theoretical replication), and two more as confirmatory (literal replication) by application of the model to a broader domain of experiences.
The critical analysis of the selected cases will be performed using a socio-technical lens since it supports investigation at a systemic level, and directs attention to how macro phenomena and micro-interactions are interrelated (Luna-Reyes et al. 2005). The CAS model proposed, combining both punctuated equilibrium and ambiguity (Merali et al. 2012), is a synthesis of the conceptualization of complexity discussed above and the contextual model of punctuated socio-technical change (PSIC) (Lyytinen et al. 2009). The PSIC model describes organizational change as a sequence of socio-technical events as the organization moves from a state of equilibrium (stable and change resistant) to disequilibrium (unstable and open to transformation) (Kauffman 1995; Snowden 2007).

**Theoretical significance of the Study**

Organizations seeking to address drivers for change are not simple random systems (Lissack 1999). Rather they are complex and heterogeneous (Allen et al. 2006). Identification of a significant, but small set of key complexity components, independent of the majority of detailed system characteristics, is a necessary precursor for development of a model relating complexity theory (Courtney et al. 2008), nonlinear dynamical systems theory (Lissack 1999) and socio-technical design principles (Hanseth et al. 2010). This project will, through the establishment of a model of the impact of complexity, explain and provide a fundamental understanding of contributory properties of IS-driven transformational systems.

**Practical significance of the Study**

Using the proposed model, decision makers will have a better view of the likelihood of success of the proposal. Although particular events are unable to be predicted (as in traditional risk approaches), an awareness of the possibility of chaotic and emergent behaviors provides the opportunity to develop strategies as agile as the anticipated project demands – the more complex, the greater the demand for responsiveness and adaptability (Fernandez et al. 2008).

Projects often take on a life of their own and continue long after many factors (such as time and cost overrun), indicate the project should be abandoned (Jenner 2010b). The broader research project will provide a toolkit for the analysis of every phase of a project and provide opportunity to both understand the emergent behaviors of complex systems and modify strategies to align the project in the narrow band along the edge of chaos necessary to implement the innovation, but not so stable as to inhibit progress (Kauffman 1995).

**Scope and Limitations of the Study**

As mentioned above, this research is bounded by projects that are transformative (that is a change based on a change in vision and/or norms/behaviors), triggered by IS implementation (including a new system environment and or innovative technology) and displaying characteristics able to be described by existing theories (i.e. primarily complexity). The model will be limited to the technical domains from which the cases are obtained (currently proposed to include 2 public sector cases (service focused) and 2 private sector cases (in reservation and commercial retail systems)).

**Conclusion**

The parameters identified in cases in the Basket of Journals and the wider literature on complexity theory has been used to develop a conceptualization of complexity. This conceptualization will be the basis for the development of a CAS model of IS-driven organizational transformations.

In summary, the literature is deficient in providing a framework to explain the variation in IS-driven transformational outcomes. Also, there is little valid evidence of practical strategy to solve complex problems associated with organizational transformation. The linear approach of conventional methods is not sufficient to ensure benefits realisation in complex transformations. Even in this early stage, this study has established complexity of nonlinear dynamics is complicit in benefit diminution. It also identifies a viable research agenda to explain the link between structure and dynamics of systems involved in complex IS-driven organizational transformations.
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